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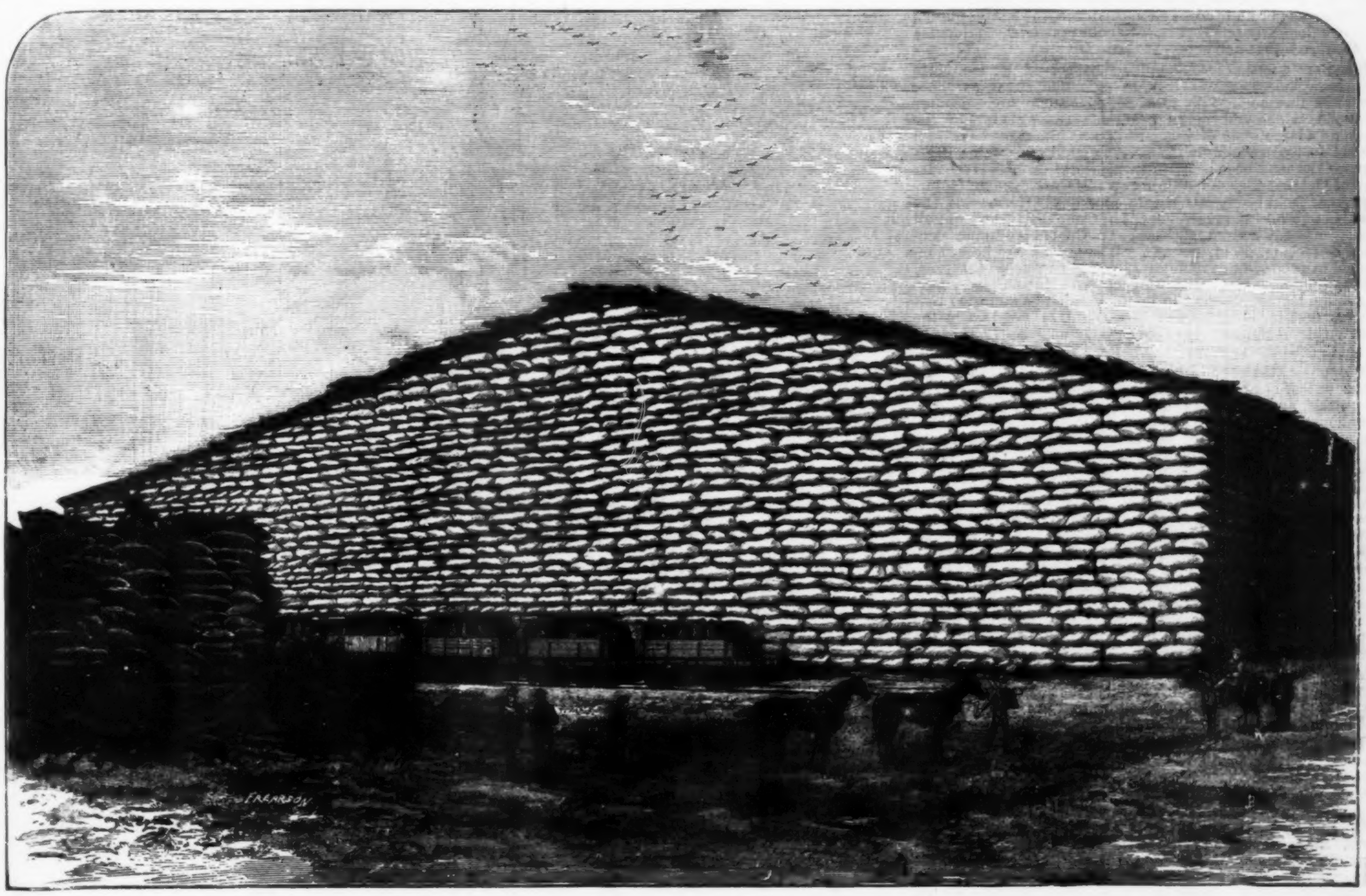
AN AUSTRALIAN WHEAT STACK.

SINCE the large extension of agricultural operations in South Australia, by the opening up of the Northern Areas, a new feature has appeared in those settlements—immense stacks of bags of wheat awaiting transport to a market. We present this week an illustration of one at Messrs. Siekmann & Moule's Caltowie Wheat Store. This little township has, from the first settlement of the farmers in the surrounding districts, been one of the most important centers of the wheat trade. Messrs. Siekmann & Moule opened a branch of their business in Caltowie at an early period in its history, about the year 1873, and have purchased immense quantities of grain from the farmers, to whom they offered great facilities for its conversion. The past season has been a very busy one in the township; the crops in the neighboring hundreds of Belalie, Mananarie, Black Rock, and Yongala having been rather above the average. Most of the produce found its way to Caltowie. All the principal firms in the wheat trade were there represented, but we are credibly informed that Messrs. Siekmann & Moule did the lion's share of the business. This was, we believe, owing to the great popularity of the firm among the Northern farmers, many of whom had been assisted and befriended by them. This firm, whose central establishment was at Saddleworth, had wheat agencies also established at Crystal Brook, Gladstone, Jamestown, Tarcowie, Yatina, Yarcowie, Farrel's Flat, and Manoora, and probably a million bushels of wheat altogether passed through their hands in the season. Owing to the deficient means afforded by the railway for carrying away the produce, large quantities accumulated along the line, and Messrs. Siekmann & Moule, after availing themselves of every inch of ground allotted to them at the railway station, were compelled to build several large stacks of bagged wheat on their own premises, about 200 yards from the line. Our illustration is taken from a photograph by Tims, and represents the celebrated stack of 35,000 bags, which attracted the attention of His Excellency Sir W. Jervois when he visited Caltowie. The removal of another large stack has already been completed, Messrs. Siekmann & Moule having gone to the expense of having a line of rails laid for 23 chains from the railway station to the stack to facilitate its removal.—*Frearson's Weekly.*



AN AUSTRALIAN WHEAT STACK OF THIRTY-FIVE THOUSAND BAGS.—FROM A PHOTOGRAPH.

POTATO dealers in New York city assert that there is no scarcity of potatoes, and that the market will be well supplied from domestic or foreign sources. It is not, however, expected that prices will rule very much lower than they now are.

THE SUGAR-BEET INDUSTRY.

From an address by ERNEST TH. GENNERT, of Portland, Me., before the State Agricultural Society of New York, at Albany, Jan. 23, 1879.

THE beet-sugar industry has, since it assumed the proportions of an industry at all, developed to such an extent wherever it has been introduced, that it is considered in most countries in Europe the most important industry; and as the consumption of sugar not only increases with the increase of population, but also with the progress of civilization, it cannot be surprising that this interest has assumed in less than fifty years such gigantic proportions. In order to understand the difficulties which we find we have to meet in introducing this industry on the Continent of North America, let us look at the exact nature of this important business.

Sugar is an organic substance containing carbon, hydrogen, and oxygen, and, as it has never been produced in any artificial way, not even in minute quantities, it cannot be denied that it is a product of the soil. It is an agricultural product, and as such it has long ago been acknowledged. Sugar has to be produced in the field; the farmer has to make it; the manufacturer only extracts it from the sugar-containing plants which the farmer produces. The principal plants which contain sugar in large proportions are the sugar-cane and the sugar-beet; all the rest together, such as the sugar maple, sugar palm, and others, form but a small fraction in the sugar supply of the world. In former years the sugar-cane was looked upon as the only plant from which sugar could be extracted; and wherever, in former times, this has been the case, the industry was invariably allied with human or negro slavery, and wherever slavery ceased to exist the production of sugar also ceased to a large extent. We have seen this on the different islands in the West Indies; later in Louisiana, and still later in Peru, where in order to produce sugar on a large scale, the very worst form of human slavery was introduced, that of the Chinese Coolies.

It is therefore but reasonable to expect whenever slavery ceases to exist in Cuba the production of sugar will cease to exist also, or be immediately decreased, and as Cuba so far has supplied a large proportion of the sugar produced from cane, some other country will have to come forward to take its place.

Beet-sugar, on the other hand, has been an offspring of science and has been ever closely allied to it. The production of beet-sugar only assumed the proportions of a national industry after science had become the handmaid of agriculture. Wherever we find the beet-sugar industry flourish, we find it combined with scientific, with rational farming, from which it is inseparable; one cannot exist without the other, and that being the case the one cannot be introduced without the other. This compels us to investigate the state of our agriculture, to understand what the beet-sugar industry has to expect from it. As the whole beet-sugar industry is decidedly of an agricultural nature, we have to treat it as such, and we will soon find what is the greatest, and in fact the only difficulty to be overcome to the successful production of $100,000,000 worth of sugar in the United States.

This difficulty, this obstacle, lies in our low state of farming; in farming land by the quantity instead of making less land with less labor applied very productive. It lies in the mistake we make to consider ourselves a prosperous agricultural nation, when we ship year after year the fertility of our land to Europe, until we shall find ourselves face to face with the Pacific ocean. It sounds very deceptive when our daily papers tell us we have shipped so many million bushels of corn, wheat, and other grain to Europe, or so many million pounds of meat, butter, and cheese to foreign countries; but it sounds quite different when we learn that the average crop of wheat per acre this year in Tennessee has been four bushels; in Ohio, which was once the garden of the United States, ten bushels; and in the whole United States it has been for many years eleven bushels. It is undoubtedly gratifying to learn that we can make as good cheese as any nation in the world, Holland, Switzerland, and England, even the celebrated Limburg not excepted, but it is quite another thing when we learn that nearly one-half the year our cows stand dry, simply because dry hay and ice water will produce neither much milk nor cream.

What then is the state of farming in countries where the beet-sugar industry flourishes? We can find in Europe no state or even district where beet-sugar had not brought with it remunerative, well paying farming, in general. We find this in every country, but perhaps in none more so than in Belgium. To say nothing of all her other industries, the beet-sugar industry in Belgium is in the most flourishing condition. Though a rather mountainous country, of which the iron and coal industries give best evidence, she exports large quantities of sugar, besides supplying her own needs. The State of New York, if cut up, could be turned into half a dozen Kingdoms of Belgium. We find here with the beet-sugar interest the most prosperous farming in Europe. According to statistics, to every two acres of land under cultivation there is kept in Belgium one head of cattle, or its equivalent in sheep or swine. A farmer who cultivates eighteen to twenty acres of land there, not only makes a good living, but he accumulates money. How many can say so here in America?

Many American farmers may shake their heads and think farm products must underlie a different law in Europe from what they do in America. Farm products bring about the same price the world over, adding freight to transport them from one point to another. If wheat is worth one dollar a bushel in America or Russia, it is worth no more in England, France, or Germany, with the addition of twenty cents for freight and other charges. Statistics show that a yield of forty bushels has been the average for many years together, in all the wheat-producing countries of Europe, and we may say safely $1.20 has been the average price.

If, then, the European farmer finds it more profitable to raise sugar-beets, and sell them at the sugar factories at from $3.60 to $4.00 per ton, where they average a crop of wheat amounting to $48, how much more profitable must it be to the American farmer, when all the gross income he has from an acre of wheat is $11, of which the smallest part, if any, is net profit? In most places in the United States, the common saying is, "The more wheat a farmer tries to grow, the poorer he will grow." It must be accepted as a principle that what one farmer does under ordinary conditions, another can do, and what ten farmers can do, ten, twenty, and hundreds more can do under the same conditions, if they will only try.

Although the most important parts in the manufacture of beet-sugar are sugar-beets, these alone are not sufficient; otherwise it would have been long ago a flourishing industry in the Dominion of Canada, where sugar-beets have been raised by the hundreds of acres, and have been offered by the thousands of acres if parties could be induced to establish a sugar factory there. But the manufacture, refining or handling of sugar requires large sums of money, and in the heretofore uncertain state capitalists are very shy to invest money in any enterprise, especially where, as in the beet-sugar business, agriculture forms an indispensable and large part of the success. The Maine Beet-Sugar Company has solved the question, "Will it pay to raise sugar-beets?" most effectually. Taking it for granted that every farmer that tries an acre of sugar-beets will, at least, put this one acre into proper and thorough cultivation, the figures quoted will convince any one that he can count on a gross income of $100 from that one acre

The next question asked and to be solved is: Do beets grown on American soil contain as much sugar as those grown in Europe, and do they contain some ingredient or substance which will make profitable the working of the same on a large scale into sugar? These questions have been conclusively answered by the success which the Maine Beet-Sugar Company has met with in its working. On the 21st day of October the company began the work of manufacturing sugar from beets, and within nine days after having the first beet go into the machinery, the company turned out all grades of sugars, from standard granulated common concrete or melada, 94,467 pounds. The quantity of beets consumed to produce this amount of sugar has been 450 tons, and as they were used with tops and even dirt on, many having rotten leaves adhering to them, it must be admitted that the result so far obtained has been fully as good as in the best sugar manufacturing countries, and better than in France.

It is one of the peculiarities of the American beet that the heads or leaf-crown contain almost as much sugar as the beet itself, and more than the average beet of France. The question of the complete financial success of the Maine Beet-Sugar Company therefore was and is centered in the supply of beets. Had this company had but sixty days' supply it would have earned a profit of not less than fifty per cent. The quality of the sugar and the quantity extracted were satisfactory in the highest degree, and the ease with which it was done could not have been surpassed. But as every new industry, which has to start on a very large scale and cannot be worked with small or cheap machinery, and which requires large quantities of raw material to work, has to overcome extraordinary difficulties not only in the working itself, but most of all in the procurement of raw material, the Maine Beet-Sugar Company adopted, in addition to the process of working green or fresh beets, the somewhat old method of working dried beets.

A drying establishment has been erected in the most northern part of the State of Maine, where the beets have been sliced and kiln-dried preparatory to transporting them to the sugar factory in Portland.

Beets treated by this process are reduced in weight, five to one, so that an ordinarily good ox team can haul ten tons of beets after they have been dried. The drying process has been adapted to the peculiarities of our country. In Europe, the drying of sugar-beets is done with coke, while here in this country, far away from communication, where wood is plenty and cheap, coke is not only very expensive but impossible to procure. After some little experimenting, the success of this drying apparatus can be better understood by comparing figures. According to authentic figures, one ton of beets converted into dry ones costs, in Germany, $9.12; this has been the average of four years, and includes every thing; while the beets dried in Aroostook County, Maine, cost the Maine Beet-Sugar Company, delivered in their sugar works at Portland, $7.15. I do not mean to assert the working of dried beets to be the best method to be adopted in America, yet it certainly facilitates the drawing of beet supply from a large territory, enabling farmers who live a long distance from transportation to avail themselves of this way of raising sugar-beets. It cannot be denied there are objections to this method of sugar-making, yet it is calculated to facilitate the introduction of the beet-sugar industry into America. The Maine Beet-Sugar Company has dried this season five hundred tons, and when the whole season's work has been finished, they will be converted into sugar, producing, probably, an additional 125,000 pounds of sugar, and bringing the whole production of the Maine Beet-Sugar Company during the first season up to a quarter of a million of pounds.

If any sensible man can show a reason why American farmers would not be benefited by the beet-sugar industry, as all the European farmers have been, I am one who would like to see the proof, and if any farmer can tell why it would be a disadvantage for him, or any one else, to try to raise an acre of sugar-beets, I should like to hear it. Every American farmer will have hard work and very small returns, until he cultivates root crops, in regular rotation, on his farm. The progress of civilization will force the introduction of the beet-sugar industry; a hundred millions of dollars will soon be insufficient to pay for the annual importation of raw sugars, but large as this sum is, it is but small compared with the general improvement the introduction of beet-growing will bring to general farming; wherever introduced the sugar beet has proved herself the queen of farm crops, and sooner or later the United States has to acknowledge her superiority.

ROLLER MILLS.

THE question as to the ultimate fate of the millstone as an implement in the manufacture of flour is one respecting which it would be rash to pronounce an opinion. Some believe that its days are numbered, that it belongs to a class of machines which, though still extant, and, indeed, largely used, have the signet of decay stamped upon them too indelibly to be removed. Others, again, are quite as firmly convinced that the centuries of life through which millstones have passed are destined to be succeeded by other centuries of existence, and that the new-fangled contrivances which have been produced in modern and comparatively recent times as substitutes for the millstone, however valuable in some respects as auxiliaries, will never supersede the millstone as a chief implement in the grinding or the granulation of wheat as a primary process in the manufacture of flour. From the development of the roller mill system that has recently taken place, it is evident the advocates of this class of machines are determined that their claims to the confidence of millers shall be prominently brought forward.

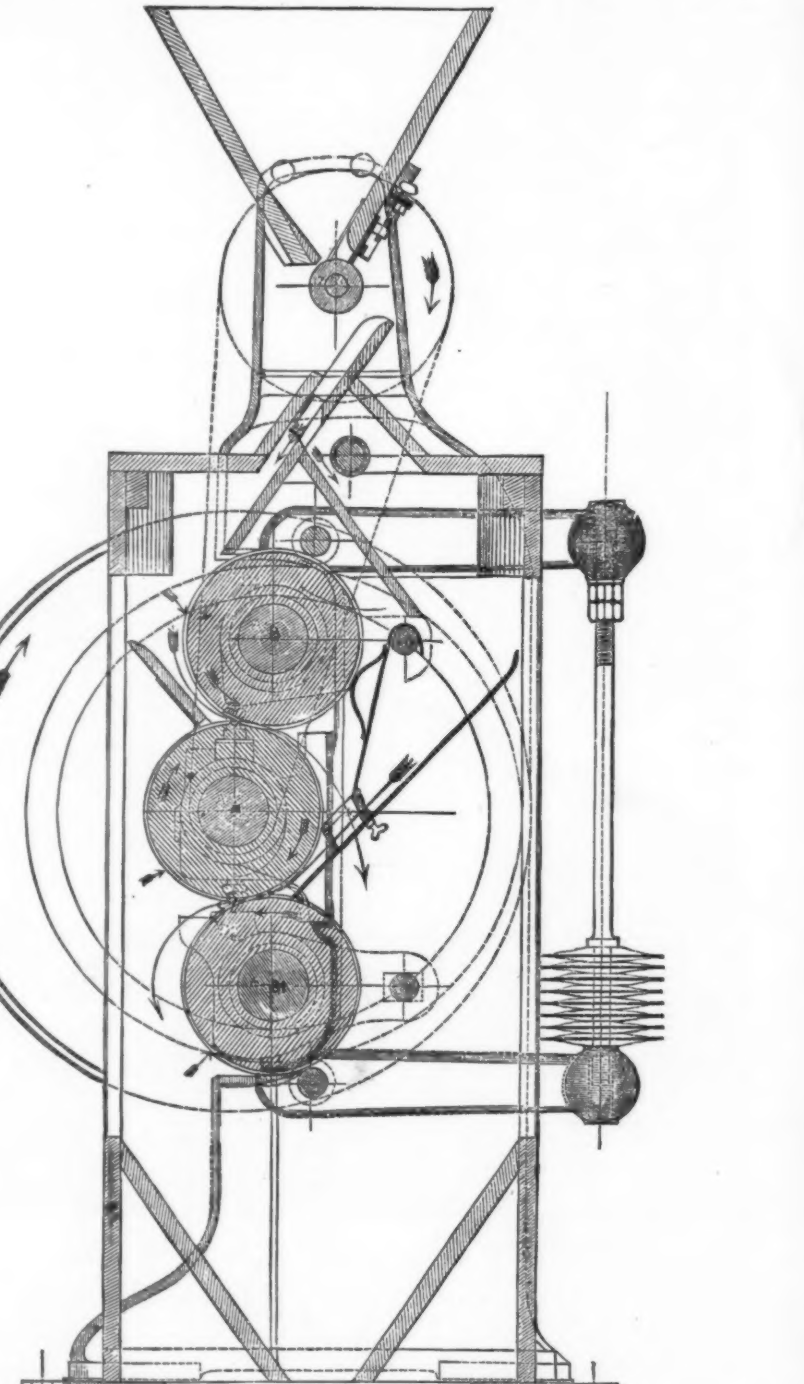


FIG. 1.—GANZ'S MECHWART'S PATENT.—ROLLER MILL (CROSS SECTION).

In February, 1878, Mr. Andreas Mechwart, of Buda Pesth, took out an English patent, No. 563, for granulating and pulverizing grain and seeds.

The specification says: "The bearings are so arranged that the rollers may be removed separately and without the necessity of taking any other portion of the machinery to pieces.

"In order to cause the swing rollers to exert the necessary pressure on the middle roller without transmitting that pressure to the bearings, their shafts carry on either side of the frame a small ring, on which a large hoop is sprung so as to embrace the two rings with the requisite pressure while they cause the hoop to revolve by their rotation.

"When necessary the pressure exerted by the inherent elasticity of the hoop may be increased by causing a pulley, suspended from an oscillating lever, to bear against the inside face of the hoop with a pressure determined by the compression of a coiled or other spring or weight at the opposite end of the lever."

Fig. 1 shows a cross section of the machine as originally patented, with the position of the rollers, which, as will be seen, are placed vertically in such a way that the three does the work of four.

The machine, however, has undergone several modifications in detail since it was originally introduced, which are specifically shown in Fig. 2. When the Messrs. Ganz, the makers, originally commenced the construction of roller mills, they directed their attention to the construction of machines with rollers of large dimensions, arranged in several sets in one frame. While space was economized by this arrangement, it was found that there was a great waste of power, in consequence of an augmented frictional resistance on the bearings, in order to obtain sufficient pressure upon the rollers. The executive result through pressure was thus neutralized by economic waste in the means used to obtain pressure, and the problem was how to minimize the friction on the bearings, and at the same time to secure sufficient pressure on the rollers, in other words, the operative parts of the machine. This was accomplished by the application to the roller pulley of an annular steel ring, by means of which pressure could be applied directly to the rollers without increasing the friction on the bearings of the implement. The ring rotates with the pulleys, and the sliding motion, which means friction, increased in proportion to the pressure, is converted into a rolling motion, without friction, the natural product of two surfaces moving contiguously in the same plane and in the same direction. The pressure upon the rollers is regulated by a tension wheel, the result being not only a substantial saving of power, but improved efficiency in the working of the rollers. The annexed figure is a side elevation of the machine which will serve to illustrate the *modus operandi* of its working.

Fig. 2 illustrates an arrangement by means of which all the pressures exerted on the rollers are resolved within the ring, the surfaces which transmit the pressures one to the other being made to roll one upon another, and hence no power is lost through friction. Here the middle roller axle is furnished also with friction wheels, *d*, between which and the steel ring, *e*, a fourth friction roller, *f*, is inserted, that turns on a bolt projecting from a toothed sector centered, or rather pivoted on the middle roller axle bearing and gearing into a worm, *x*, which adjusts the position of the friction wheel, *f*, around the middle roller axle, and since the

ring center does not coincide with the axis of this roller it determines the eccentricity of the ring, which again regulates the pressure exerted on the outer rollers or friction wheels, *d d*.

In order to provide a means for adjusting the pressure simultaneously on both sides of the machine, the bolt on which the upper swinging roller oscillates is cranked, so that the lever, *g*, is moved upward, the axis of oscillation is advanced, and since the friction wheel, *f*, on each side of the machine, hold the rings from following, the pressure exerted by the ring is again increased, but in this case, as previously stated, simultaneously on both sides.

To neutralize the weight proper of the bottom roller, balance weights, L*i*, are provided. The bolts on which the

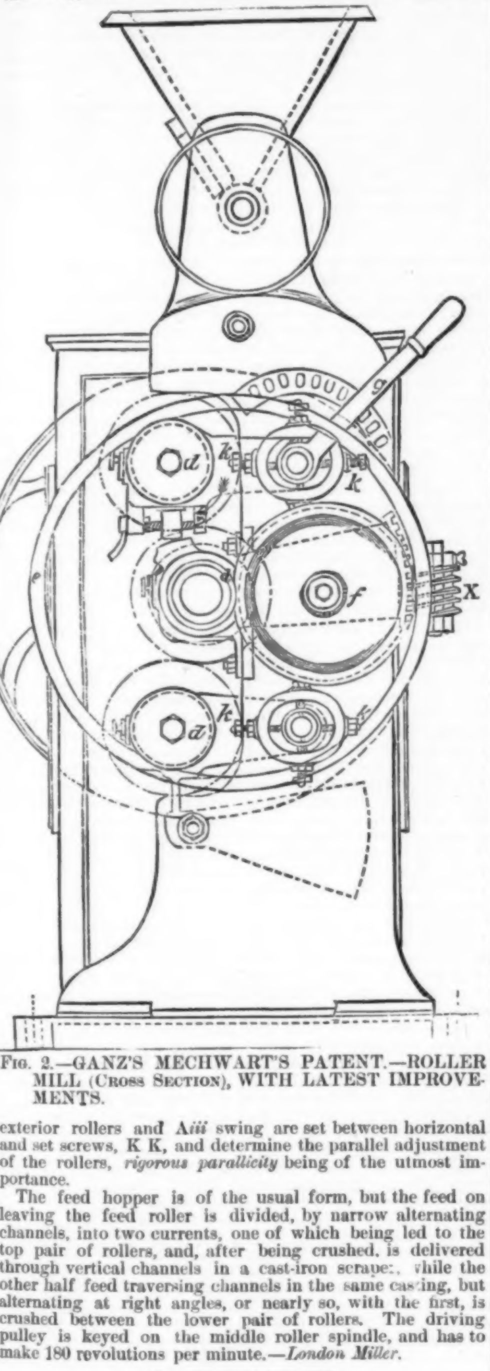


FIG. 2.—GANZ'S MECHWART'S PATENT.—ROLLER MILL (CROSS SECTION), WITH LATEST IMPROVEMENTS.

exterior rollers and A*iii* swing are set between horizontal and set screws, K K, and determine the parallel adjustment of the rollers, *rigorous parallicity* being of the utmost importance.

The feed hopper is of the usual form, but the feed on leaving the feed roller is divided, by narrow alternating channels, into two currents, one of which being led to the top pair of rollers, and, after being crushed, is delivered through vertical channels in a cast-iron scraper, while the other half feed traversing channels in the same casting, but alternating at right angles, or nearly so, with the first, is crushed between the lower pair of rollers. The driving pulley is keyed on the middle roller spindle, and has to make 180 revolutions per minute.—*London Miller.*

HOW TO FEED FOR EGGS.

A CORRESPONDENT of the new *Poultry Monthly*, published at Albany, says:—The question is asked me often how I feed my poultry to get so many eggs through the cold weather. They say they feed their fowl all the corn they will eat, but they do not get any eggs. My fowls are always healthy, never have any kind of disease, and I always get plenty of eggs when they bring the highest price. In the first place I keep pure breed poultry, not mongrels; next, my fowls always have all the old plaster, lime, oyster and clam shells broken fine, burned bones, charcoal and gravel they require, a good dust box to wallow in, plenty of good water, not snow and ice, bone meal and meat scraps twice or three times a week, and sour milk when I have it. Now, for the first meal, potatoes and meat scraps boiled, mashed, a little salt, thicken with corn meal and wheat shorts; second meal, buckwheat; third meal, corn. Second day, potatoes and turnips boiled, mashed, seasoned, thickened with corn and oats ground; second meal, wheat screenings; third meal, buckwheat. Third day, potatoes and onions boiled, seasoned, mash, thicken with ground feed and a few handfuls of bone meal; second feeding, oats; third meal, corn. Fourth day, potatoes and meat scraps, mashed, seasoned well with Cayenne pepper, thickened with meal and shorts; second meal, buckwheat; third meal, wheat screenings. Fifth day, potatoes and sweet apples boiled, seasoned, mash, and thicken with wheat shorts; second meal, corn; third meal, oats. Sixth day, potatoes and onions boiled and mashed, thicken with corn and oatmeal; second meal, wheat; third meal, corn; an extra feeding of sunflower seeds once in a while, I find is very good. Seventh day, potatoes and turnips boiled and mashed, season with Cayenne pepper, thicken with wheat shorts and bone meal; second meal, oats; third meal, buckwheat. This is the way my fowls are fed through cold weather.

FARM LAW.

Address of Hon. EDMUND H. BENNETT, of Taunton, Mass., delivered before the Massachusetts State Board of Agriculture, at Hingham, December 4, 1878.

IN an article upon the "Rights and Duties of Farmers," we shall naturally be expected to treat of those rights and duties which are peculiar to farmers, or rather, such as are peculiarly important to them; and if you find me unusually dry in my presentation of it, you will remember that it is an unusually dry subject, though to those pecuniarily concerned, not wholly devoid of interest. And naturally the first inquiry is—

HOW TO BUY A FARM.

It is quite generally known that a mere oral bargain for a farm is not binding in law upon the owner, but it may not be so well understood that an offer to sell a farm for a given price, even though it be by letter, or other simple writing, may not be binding upon the proposer until it is actually accepted by the buyer, and he has also agreed to take it and pay the price stated in the offer. Therefore the owner may retract his offer to sell at any time before it is accepted and he is notified thereof. And although in making his offer to sell he should expressly give you a certain number of days in which to decide, he may nevertheless change his mind in the meantime and sell to another who offers a higher price, even before the given time has expired, and you would have no legal redress for your disappointment.

Nay, more; although you had fully made up your mind to take the farm, but had not notified the vender of that fact, and should go to great trouble and expense in buying stock, tools, agricultural implements, etc., to carry on the farm, and should even move your family there to take possession, the owner might even then refuse to sell, and you would have no legal remedy either to compel him to convey, or for the expenses you had thus incurred, relying upon his keeping his word. The only safe way in such cases is to take a *bond* for a deed, as it is called; an ordinary "refusal" of property, for a stated time, as it is termed, is a dangerous thing to rely upon, unless you are dealing with a man "whose word is as good as his bond," and they are very scarce. And if a particular time is given you in which to accept an offer to sell, you should be particular to signify your acceptance strictly within the time, and to do so entirely unconditionally. In one instance a man had 10 days in which to make up his mind, and on the night of the last day, about half-past 11 at night, he called at the owner's house, after he was abed and asleep, and said he would take the farm. The owner refused to get up or to take the money the next day, and the buyer tried to get the farm by a suit at law, but it was decided that he came too late, on the last day, and he not only lost his trade, but had to pay the costs of his suit (26 Miss., 309). In another case A wrote to B he would sell him his farm for $3,000 cash. B wrote back immediately he would take it if A would make out his deed and send it to a lawyer for examination, and if all right the lawyer would pay him his $3,000, but it was decided that B had not duly accepted A's offer, and consequently that he might withdraw it (53 Me., 511). But supposing the grantor is willing to give you a deed, it is unnecessary to say that it must have the seal of the grantor attached, or it is not sufficient. A scroll of the pen, or the letters L. S., are not sufficient in Massachusetts, as in some other States. It may not be as well understood that it is not equally necessary that a deed should be witnessed or acknowledged and recorded. These last requisites may be necessary to make the deed valid against creditors of the grantor, or any one who subsequently bought the farm without knowing of the prior deed; and they are always so important they should never be neglected, and my first advice to you is that if you find any unrecorded deeds among your papers when you go home, you attend to that duty forthwith. Having once obtained a sufficient deed, the next question seems to be—

HOW FAR THE FARM EXTENDS,

or its proper boundaries. Three circumstances have more or less weight in determining this question: 1st. The number of acres stated in the deed; 2d. The boundary lines running around the farm; 3d. The area inclosed within the visible monuments, such as trees, rocks, stake and stones, described as corners of the farm. Of these three, the last is by far the most important, and in case of any difference between them, controls all the rest. If the boundary lines are described as beginning at a certain stake and stones, thence to a certain tree, thence to a particular rock or stump, and so quite around the farm, the deed conveys all the land inside of these monuments, although it may be many more acres than the deed calls it; and on the other hand it will include no more, although the number of acres stated really requires more land to satisfy its number. So if the monuments named are fixed and definite, they control the length of the side lines mentioned in the deed, and if these be called 100 feet long on every side, but the trees, rocks, stake and stones described are only 90 feet apart, the buyer will acquire a lot only 90 feet square, and not 100 feet; and *vice versa*, if the lines are described as only 90 feet long, but the given corners are 100 feet distant, the deed covers a lot 100 feet square. The quantity of acres mentioned is the very weakest means of knowing the extent of the farm, even if the words "more or less" be not used, as is so commonly done, and generally speaking a deficiency in number of acres gives the buyer no remedy against the seller for any return of part of the purchase money, unless, perhaps, when it was clearly bought at the rate of so much per acre. So much more important are the known monuments and boundaries than the number of acres stated, that even if the vender fraudulently and intentionally overstates the quantity, in order to deceive the purchaser, the latter has no redress, if so be the other truly pointed out the boundaries in making the trade (102 Mass., 217); whereas a fraudulent statement of the boundaries would annul the sale, even though the farm contained as many or even more acres than the parties called it in making the bargain (9 N. Y., 183).

If a boundary line runs to a tree, rock, stump, or other similar object, it goes to the center of the object; if it runs by a wall or fence it passes through the middle of it, and not by the side, which in a "Virginia fence" might be of some consequence.

So if the farm bounds by or on a brook, river, stream, etc., it usually extends to the middle of the current; not always to the middle of the *water*, but to the thread of the stream—*ad filum aquæ*. If there be any islands between that center line and the bank, they belong to the owner of the main bank. In like manner, if a deed is bounded on a mill pond, reservoir, pond, or any artificial pond through which a perceptible current makes its way, the farmer ordinarily owns to the center of the current; on the other hand, if it be a large natural pond or lake, the line stops at the low water mark on the shore, and does not extend into the pond, the public having right to such large bodies of water as are useful for navigation, boating, sailing, and the like.

As to farms bounding on the sea shore, some peculiar provisions as to the extent thereof exist in this State.

That strip of land between high and low water mark, generally termed "the flats," is a frequent subject of contention, and the question is often made to whom it belongs; whether to the owner of the upland or to the public. By force of a very early law in Massachusetts (contrary to that of most other sea coast States), if a deed describes the farm as bounding "by the sea," "by the salt water," "bay, harbor, cove, creek, stream, river, or tide water," it generally includes the whole flats down to low water mark, if not over 100 rods, including the exclusive right to gather the sea weed, or other such things washed up thereon by the tide. On the other hand, if the deed bounds "by the shore," "beach, strand, flats, marsh or cliff," it extends only to high water mark, and does not give any right to the flats.

While yet again—such are the niceties of the law—if the phrase of the deed is "to the beach *or* sea," "to the *sea* shore," "to the sea *or* flats," the grantee owns down to low water mark, flats and all. In view of such nice and subtile distinctions, one is tempted to exclaim with the Earl of Warwick in Shakespeare's "Henry VI.:"

> "Between two hawks, which flies the higher pitch,
> Between two dogs, which hath the deeper mouth,
> Between two horses, which doth bear him best,
> Between two girls, which hath the merriest eye,
> I have, perhaps, some shallow spirit of judgment,
> But in these nice sharp quillets of the law,
> Good faith, I am no wiser than a daw."

WHAT A DEED OF A FARM INCLUDES.

Of course every one knows it conveys all the fences standing on the farm, but all might not think it also included the fencing stuff, posts, rails, etc., which had once been used in the fence but had been taken down and piled up for future use again in the same place (2 Hill, 142). But new fencing material just bought and never attached to the soil would not pass (16 Ill., 480). So piles of hop poles, stored away, if once used on the land have been considered a part of it (1 Kernan, 1. 3); but loose boards or scaffold poles laid loosely across the beams of the barn and never fastened to it would not be, and the seller of the farm might take them away (1 Lans., 319). Standing trees, of course, also pass as part of the land; so do trees blown or cut down and still left in the woods where they fell (54 Me., 309), but not if cut and corded up for sale; the wood has then become personal property.

If there be any manure in the barnyard, or in a compost heap on the field, ready for immediate use, the buyer ordinarily takes that also as belonging to the farm; though it might not be so, if the owner had previously sold it to some other party and had collected it together in a heap by itself (43 Vt., 95). Growing crops also pass by the deed of a farm, unless they are expressly reserved, and when it is not intended to convey these, it should be so stated in the deed itself; a mere oral agreement to that effect would not be valid in law (19 Pick., 315). Another mode is to stipulate that possession is not to be given until some future day, in which case the crops or manure may be removed before that time.

As to the buildings on the farm, though generally mentioned in the deed, it is not absolutely necessary they should be. A deed of land ordinarily carries all the buildings on it belonging to the grantor, whether mentioned or not; and this rule includes the lumber and timber of any old building which has been taken down, or blown down, and been packed away for future use on the farm (41 N. H., 505; 30 Penn. St., 185). But if there be any buildings on the farm built by some third person, with the farmer's leave, the deed would not convey these, since such buildings are personal property and do not belong to the landowner to convey. The real owner thereof might move them off, although the purchaser of the farm supposed he was buying and paying for all the buildings on it. His only remedy in such case would be against the party selling the premises. As part of the buildings conveyed, of course the window blinds are included, even if they be at the time taken off and carried to a painter's shop to be painted. It would be otherwise if they had been newly purchased and brought into the house but not yet attached or fitted to it (40 Vt., 233). Lightning rods also go with the house, if a farmer is foolish enough to have any on his house. A furnace in the cellar, brick or portable (4 E. D. Smith, 275; 39 Conn., 362), is considered a part of the house, but an ordinary stove with a loose pipe running into the chimney is not (24 Wend., 191), while a range set in brick work is (7 Mass., 432). Mantelpieces so attached to the chimney as not to be removed without marring the plastering go with the house, but if merely resting on brackets they may be taken away by the former owner without legal liability (102 Mass., 517). The pumps, sinks, etc., fastened to the building are a part of it in law (99 Mass., 457) and so are the water pipes connected therewith bringing water from a distant spring (97 Mass., 133). If the farmer has iron kettles set in brickwork near his barn for cooking food for his stock, or other similar uses, the deed of his farm covers them also (10 Pick., 314), as likewise a bell attached to his barn to call his men to dinner (112 Mass., 514). If he indulges in ornamental statues, vases, etc., resting on the ground by their own weight merely, and sells his estate without reservation, these things go with the land (12 N. Y., 170).

RIGHTS IN THE ROAD.

If a farm deed is bounded by or upon a road it usually extends to the middle of the roadway. The farmer owns the soil of half the road, and may use the grass, trees, stones, gravel, sand, or anything of value to him, either on the land or beneath the surface, subject only to the superior rights of the public to travel over the road, and that of the highway surveyor to use such materials for the repair of the road; and these materials he may cart away and use elsewhere on the road. No other man has a right to feed his cattle there, or cut the grass or trees, much less deposit his wood, old carts, wagons, or other things thereon (8 Met., 576; 8 Allen, 473; 1 Pa. St., 336). The owner of a drove of cattle which stops to feed in front of your land, or of a drove of pigs which root up the soil, is responsible to you at law, as much as if they did the same thing inside the fence. Nobody's children have a right to pick up the apples under your trees, although the same stand wholly outside of your fence. No private person has a right to cut or lop off the limbs of your trees in order to move his old barn or other buildings along the highway (4 Cush., 437), and no traveler can hitch his horse to your trees in the sidewalk without being liable, if he gnaws the bark or otherwise injures them (54 Me., 460). If your well stands partly on your land and partly outside the fence, no neighbor can use it except by your permission. Nay, more, no man has a right to stand in

front of your land and insult you with abusive language without being liable to you for trespassing on your land (11 Barb., 390). He has a right to pass and repass in an orderly and becoming manner; a right to use the road, but not to abuse it. But notwithstanding the farmer owns the soil of the road, even he cannot use it for any purpose which interferes with the use of it by the public for travel. He cannot put his pig pen, wagons, wood, or other things there, if the highway surveyor orders them away as obstructing public travel. If he leaves such things outside his fence, and within the limits of the highway as actually laid out, though some distance from the traveled path, and a traveler runs into them in the night and is injured, the owner is not only liable to him for private damages (15 Conn., 225), but may also be indicted and fined for obstructing a public way. And if he has a fence or wall along the highway he must place it all on his own land, and not half on the road, as in case of division fences between neighbors (4 Gray, 215). But as he owns the soil, if the road is discontinued, or located elsewhere, the land reverts to him, and he may inclose to the center and use it as a part of his farm.

AS TO FARM FENCES.

It was a fundamental principle of our law (contrary to that of many of the United States) that every man must keep his cattle on his own land at his peril. He was liable if they strayed away into other people's grounds. It was necessary, therefore, at common law, that every man should keep a personal watch over his animals or surround his land with a fence. This fence was primarily, therefore, not to keep other people's cattle out, but to keep his own in; and so each owner, if he kept cattle, was bound to erect the entire fence around his close, whether his neighbor kept any cattle or not, and if the latter also owned any, he must do the same, or keep his beasts at home in some other way. But as two parallel fences would be attended with useless expense, and as one and the same fence would answer for two adjoining proprietors, it was long ago provided by statute law that adjoining owners of improved lands should maintain partition fences in equal shares. And if they did not agree how the fence should be divided, each might apply to the fence viewers, elected by the town every year, to decide which half each proprietor should keep up. And if, after such decision, each party refused or neglected to build or keep in repair his portion, the other could do so and recover the expenses of the delinquent owner by a suit at law. It follows, therefore, that if my adjoining owner does not keep up his half of the fence and my cattle get through and injure his crops, he has no redress against me, since his own neglect was, in part, at least, the cause of his injury. But now comes in a very important addition to this rule; and this is, if my cattle stray beyond the immediately adjoining land, into the farm of a third person, and these injure his crops, I am liable for the damage to him, although my own half of my fence is good, and my animals escaped through my immediate neighbor's defective fence; because as to all persons except my nearest neighbor, I am still bound to keep my cattle on my own land, and it is no excuse for me that my neighbor neglected his half of our division fence. Nay, so far is this rule carried, that although such third person did not keep up his own fence, and the cattle go into his land through his own fault, he can still make me pay the damages, because he is not bound in law to keep up any fence at all, except as against his nearest neighbor, and not against any cattle further off. In other words, if A, B, and C own three adjoining lots, and A's cattle stray into B's land, through B's neglect, he has no remedy against A; but if they stray still further on to the land of C also, and there do mischief, C has a claim for the damages against A, even though the animals went through his own broken down fence. A must keep his animals at home at his own peril.

For similar reasons, if A turns his cattle into the highway and they come on to your land from the road, either because your front fence is defective or altogether gone, you have a remedy against A for all the damages you sustain, for you are not obliged to have any fence on the road, except to keep your own cattle in, and A must keep his own cattle at home. And so stringent is the rule, that if other people in roaming over your ground, hunting, fishing, or berrying, leave your bars down, by which your cattle escape into the highway and thence come into my cornfield, you are responsible to me for all the damage, although not actually in fault, if you kept all your fence up (30 N. H., 143). On the other hand, if you are carefully driving your cattle along the highway, and without your fault they break away from your control and run into my adjoining land, and you drive them as soon as you reasonably can, you are not responsible for the damage done, for you had a right to drive them along the highway, with proper care and attention (114 Mass., 466), while in the other case they were not lawfully in the highway at all, although the owner was not personally at fault.

The proper legal height of all division fences in this State is four feet, and they may be made of rails, timber, boards, or a stone wall. A brook, river, pond, ditch, or ledge may also be sufficient, or any other things which the fence viewers consider equivalent to a four foot rail fence. The number of rails is not prescribed by law.

These division fences may be placed one-half on each side of the line, even though ditches be used three feet wide (2 Met., 180) and both owners have a common interest in the whole fence; and they must be kept in good repair throughout the entire year, unless both parties otherwise agree. But the duty of maintaining partition fences by statute exists only when both parties improve their lands. It would not be just to make a man whose lands are wild, or not improved, and on which he neither has cattle to stray away and injure others, nor growing crops which can be injured by other people's animals, to pay the expense of building or maintaining a fence which can be of no advantage to him. Accordingly, if one of the adjoining owners improves his land, he has no right to compel the other to pay any part of the expense of a fence; and if he needs a fence to keep his own animals at home, or for any other purpose, he must build it himself. If, therefore, A owns a pasture lot alongside of B's wood lot, the latter is not bound by statute to help maintain a fence between them, but if A puts cattle into his pasture he must keep them there as best he can, either by watching them, or, if he thinks it cheaper, by building a fence himself around his entire lot. So, if both are wood lots, the owners are not obliged to erect a fence, but if either allows his cattle to range the woods, he must take care they do not browse through his neighbor's woods, or he will be responsible.

The sum of the whole matter is this: By the common and general law every man is bound to keep his own cattle on his own land at his peril. The duty of doing this by a fence is created wholly by a statute of the Commonwealth, and need not be made except where the statute clearly requires it.

What we have thus far said as to the joint expense of fences relates only to *partition fences* between two farmers. As to fences along a railroad, the law is quite different. The general railroad law requires the company to maintain a suitable fence along the whole line, through woodland as well as improved land, and the farmer has no part of the expense to pay. This railroad fence need not be always four feet high, nor need it always be so close as the division fence between two landowners. It must be "suitable" merely—suitable for the place where it is situated; and through the woods or where there is little or no danger of animals straying on to the track, it might be quite light and yet comply with the law. But if any cattle of an adjoining landowner do escape through it on to the track through its unsuitableness, and are there injured by a passing train, the company is responsible. But here again the same principle comes in which we have before stated, viz.: the company is not bound to fence out everybody's cattle, but only those of the landowner immediately adjoining. If, therefore, the animals of one remote from the railroad break out or stray away from their pasture, and after wandering over the intermediate lands finally find their way on to the railroad, and there meet their death, the railroad company is not liable; the owner should have kept his cattle on his own lot, and not allowed them to trespass on others' lands (98 Mass., 560). Of course, if they were lawfully pasturing on the lands near the railroad, by permission of the landowner, they could be protected in the same manner as his own animals are.

IMPOUNDING CATTLE.

Closely connected with the subject of fences is that of impounding animals. If you find your neighbor's cattle in your cornfield, there are three courses you may pursue. 1st, You may put the animals in the town pound; 2d, You may sue the owner for damages; 3d, Or you may quietly turn them into the highway and say nothing. Of these three the last is the easiest to be done, and the hardest to make up one's mind to do. We are directed in the good Book to forgive our neighbor his trespasses, but it says nothing about forgiving his cattle their trespasses. If a man ever allows himself to violate the Third Commandment he is tempted to use that outlet for his indignation when he jumps up from the dinner table on a hot day in July to drive his neighbor's breachy cattle for the seventh time out of his garden or cornfield.

The second remedy of a suit at law is more peaceful, but slower, and more likely to benefit the lawyer than the farmer. Impounding is the most summary, and generally the most effective, but is surrounded with legal dangers, and a slight mistake is often fatal; and like some other dangerous weapons may kick backwards and cause considerable damage to the one employing it.

The general outline of this remedy is this. If any person actually finds any sheep, swine, horses, or neat cattle doing damage on his land, he may drive them to the town pound or some other suitable place, giving them sufficient food and water, or he may shut them up in his own yard for a reasonable time before driving to the pound, and in the meantime send a memorandum to the owner of the animals stating the cause of impounding them, the amount of damage done by them, the charges for feeding, etc., in order that the owner may come and pay the damages and take away the beasts. If he does not come, or if the party impounding prefers, he may in the first instance drive them to the pound or send for a field driver (who is generally the last married man in town), and request him to impound them, sending a similar memorandum to the pound keeper, and also a written notice of the fact to the owner of the animals within 24 hours, containing a description of the beasts and a statement of the time, place, and cause of impounding. Before the owner can release his animals he must pay the damages and all the expenses; and if he declines to do so, they may be sold by public auction, and the balance of the proceeds above the expenses deposited with the town treasurer for the benefit of the owner. This remedy seems to be seldom resorted to in modern days, for in most of the town pounds, which we pass, we notice that the gate is entirely gone or so dilapidated as to furnish very little security against the escape of animals confined therein; nevertheless, every town is liable still to a fine of $50 for not keeping one or more suitable pounds.

A recent law of this Commonwealth has added one more protection against invading animals, making the owner of any sheep, cattle, horses, swine *or fowls* liable to a fine of $10 if he willfully allows them to enter another orchard, garden, mowing land or other improved land, after receiving written notice from the owner forbidding it (St. 1878, c. 168). This statute extends to fowls, which the laws in regard to impounding did not.

FARMER'S LIABILITY FOR HIS ANIMALS.

Passing from the subject of cattle straying away and doing damage to other people's grounds, we have next to consider how far the farmer is liable for their good behavior in the public streets, or even on his own premises. And it may not be generally understood that if a man turns his animals loose into the public highway and they there injure the person or property of another, lawfully using the way, the owner is responsible for all damages they may do, whether he knew that they had any dangerous disposition or not (4 Allen, 444). He had no right to let his cattle run loose in the public highway. In one instance a man let his horse go out to feed in a public place where some very young children were playing, and some of them began to switch him, whereupon he turned and kicked one of them so that he died, and the owner was convicted of manslaughter. Had he known the animal was dangerous it might have even been more serious with him, since, in the Mosaic law, it was declared that if the owner of an ox knew that it pushed with his horns, and did not keep it in, and it killed a man or woman, not only the ox but also the owner was put to death (Ex. xxi. 29).

And now as to his liability for animals on his own premises. Every owner of a dangerous or vicious animal, known to be such, is liable for all injury he may do to another, even though the latter is at the time trespassing on the former's premises (3 E. D. Smith, 574). If, therefore, a boy while robbing an orchard, is loped by a vicious bull into the boughs of the apple tree overhead, the owner is as much liable in law to pay for the boy's torn trowsers as if had received the same salutation when coming up the path to call on the farmer's youngest daughter. But this extreme and severe liability absolutely depends upon the fact whether the owner of the animal had any previous knowledge of the brute's warlike disposition. If so, the mere keeping of such an animal unconfined is itself, in law, deemed culpable negligence. If he did not know the fact some other form of negligence is essential in order to make an owner of an animal liable for his conduct while on the owner's premises, or while lawfully in the highway under the care of a keeper. For this reason if a man's horse runs away in the street and injures some one, or breaks a carriage, the owner is not liable unless he carelessly left him unhitched, or was guilty of some other negligence. The not uncommon opinion to the contrary is quite erroneous.

DOGS.

The question of liability for and protection against dogs has been a perplexing one from earliest times. The laws of Solon—undoubtedly the wisest law-giver of his age—declared that if any dog bit a person he should be delivered up and bound to a log of wood four cubits long; and the Romans also adopted the same law in their "Twelve Tables," while an early law in Wales provided that after a dog has bitten three persons he should be first tied to his master's leg and then killed.

Owing to the naturally wild and fierce disposition of dogs, it has not been generally thought necessary in order to make the owner liable to prove that he actually knew the dog was accustomed to bite, as it is in the case of other domestic animals. The law presumes that the son of every Puritan farmer in Massachusetts has been brought up from boyhood to repeat those lines of good old Dr. Watts:

"Let dogs delight to bark and bite,
For 'tis their nature to."

Accordingly the owner is liable, if they do, whether his education on this point had been neglected or not (3 Allen, 191). And not only so, he must with us pay double damages for the pleasure of keeping such animals, and which after actual notice may be increased to threefold. And so comprehensive is the law that if your dog rushes out into the street and in mere play jumps at a horse's head, whereby he is frightened and runs away, breaking the carriage and perhaps the limbs of the occupants, you are responsible for double the amount of the entire damage, though it amounts to several thousand dollars; for the liability of the owner is not limited to damages from the *bite* of a dog, but extends to any direct injury however caused (1 Allen, 191). Again, if your dog is at large, although he is a good-natured Newfoundland, and being teased and irritated by young children at play, turns upon them and bites one severely, you may be liable to heavy damages, although the dog was never known to bite before (4 Allen, 431). And this is so, although the dog is duly licensed and collared. The object of the dog tax was not to exempt the owner of a dog, when known, from his former liability for all his dog's mischief, but to provide a fund for the remuneration of the farmer, when the owner was not known, or was not pecuniarily responsible. Accordingly any man injured in his person or property by a dog may now have either mode of redress; he may file his claim with the selectmen and take simply the amount of damages he may have sustained, or he may go for the owner of the dog and get double damages, if he can; but he cannot try both methods. If he is paid his simple damage out of the dog tax, the county may compel the owner of the guilty dog to refund the amount paid out. But no man is obliged to wait until the mischief is done, and then seek for redress by the law's delay. You may take the law into your own hands, and kill the dog, licensed or not, that suddenly assaults you while peaceably walking or riding in the public streets, and so you may if the dog is found out of the inclosure or care of the owner, wounding, worrying, or killing any neat cattle, sheep, or lambs.

If a dog is not licensed your right to kill him is much broader. [The law licensing dogs in Maine was repealed by the recent session of the Legislature.] The law says: You may kill him "whenever or wherever found." These are its exact words. But if you think this authorizes you to kill him on his owner's premises, and should pursue him into the owner's house and then kill him, contrary to his owner's wishes, you might find out your mistake by being compelled to pay, not only the full value of the dog, but also for unlawfully entering another's premises (11 Allen, 151; 109 Mass., 276). "Whenever and wherever found," therefore, doesn't mean exactly what it says. Such are the quirks of the law. Some people call it a sort of "hocus pocus science."

Again, do not think, that because you can openly and publicly shoot an unlicensed dog which is hanging around your premises annoying your family, you can therefore poison him, for even the exposing of any poison for that purpose, whether the dog touches it or not, may cost you $50 and the cost of prosecution. And this is very moderate considering that for the malicious poisoning of some other domestic animals—even a sucking calf—you may obtain a free residence in that splendid new State building at Concord for five years, unless you see fit to break out before that time. Thus much for the law of dogs. And the only crumb of consolation I can offer you on this subject is this: if two dogs, yours and your neighbor's, go off on a joint raid on a flock of sheep, you are bound to pay only for those your dog killed, and not the others, if anybody can find out which was which (20 Pick., 477); whereas if the two owners of the dogs go out together to rob a melon patch, either one is liable for all the melons carried away; so that in one respect the law seems to favor the dogs. On the other hand, as a man is not liable for any mischief which his boys may do while trespassing on other people's grounds, in this respect again the law is rather against the dogs.

WATER RIGHTS AND DRAINAGE.

Water is flowing and fleeting, and the rights of farmers therein are much of the same kind. If a stream of water flows through a farm, the owner has a right to use any reasonable quantity of it, as it flows along, for watering his stock, irrigating his land, or supplying his house for domestic use; but he must not monopolize the whole. His neighbor's cattle must have water also. He may to some extent change the course and flow of the brook on his own land, provided he turns it back into the natural channel before it reaches the land below him. He has no right to conduct it into his neighbor's land, without his consent, at a different point or place than where it naturally entered therein. He may build fish ponds or otherwise dam up the stream, provided he does not thereby flow back on the land above him. If he does so, he is liable to a suit for trespass, and finally, if he continues it, to an injunction. A farmer acquires no right to flow another's land, without his consent, as a mill owner has, as the statutes giving such right upon payment of a fair compensation, apply only to milldams and the like, and if your neighbor below you so dams up the stream as to flow back on you, you may enter on his land and take down enough of the obstruction to relieve your land of the overflow.

So if a natural stream becomes obstructed by leaves, sticks, and rubbish, you have a right to go on to the land and remove the obstruction, so that the water will flow as

freely as before (5 Met., 429); and the natural deposits you may place on the banks of the stream (21 Pick., 341). The same rule prevails as to artificial water courses or ditches, provided you have acquired a right to have such running through another's lands. But you have not ordinarily such a right unless you or your predecessors have purchased the privilege of him, or have enjoyed it so long and under such circumstances as to have thereby gained a *prescriptive right*, as it is called, or lastly, have the ditch opened by commissioners appointed by the Court under the General Statutes, c. 148.

The right and liabilities of farmers in *surface water* are very different in this State from those in the flowing or running streams. By "surface water" is meant not only that which comes from falling rains and melting snows, but also that which oozes out of the ground from springs or marshy places, and which finds its way over the surface, or through tussocks, but is not gathered into a bed or current like a brook or rivulet. When once collected into a stream, with a bed and banks, it loses its character as surface water and becomes subject to different rules. But so long as it is only surface water, any man on whose land it is has a right to detain and use the whole of it on his own land and for his own purposes, and is not bound to let any portion of it flow on to the land below, unless he wishes. On the other hand, he may turn the whole of it on the premises below him, whether grass lands or cultivated fields, even though it be a serious injury to such neighbor (120 Mass., 99). If the latter wishes to protect himself he must build up some embankment at the edge of the land and stop the flow, as he has a perfect right to do, although he thereby makes quite a pond above and injures the crop there. And as the farmer may turn the surface water from his own land into yours, without being liable, so a highway surveyor may conduct the road wash on to you, even though it sweeps sand and gravel into your best mowing. If he turns a *water course* on to you in that way, you may appeal to the selectmen, under General Statutes, chap. 44, sec. 10, to have it changed, but surface water you must take or dam it over; that you can do, but you ought not to damn the surveyor for turning it on to you.

As to *underground* water, the law does not recognize any right of ownership therein, and consequently if your neighbor's well is fed by springs or underground rills from your land, you may dig down to any depth you please, and near to the line, and if by chance you cut off the supplies to his well and leave it dry, he must bear it as well as he can (18 Pick., 117). But you must be careful in digging not to let his land cave into your excavation, or you may be responsible therefor.

TRESPASSING ON THE FARM.

The general rules in regard to trespassing on another's lands are pretty well understood in the community, but on one point there is sometimes an erroneous impression. It is often thought that if a person simply crosses your land for twenty years he thereby always acquires a right to continue the practice, but this is far from being universally true. The very foundation of acquiring such a right—a prescriptive right, as it is called—is that the crossing must have been adversely to the land owner, contrary to his wishes, or at least without his permission, expressed or implied, and under a claim of a legal right to do so, whether the farmer is willing or not. If, therefore, the person crossing does so with the permission, or by the mere indulgence of the land owner, and not under any claim of right, it is wholly immaterial how long the custom has continued. Forty years' travel by consent of the owner would not give any right to continue to pass after he had been forbidden to do so. And to avoid any misapprehension in such cases, it is wiser for the farmer to put up notices forbidding it, as we often see done. And this not only makes it clear that thenceforward the intruder is a trespasser, but by a recent law in this State he is also made liable to a fine of $20 ($5 in Maine) for willfully crossing or entering upon any garden or orchard mowing lands or other improved land, between the first day of April and the first day of December (St. 1876, c. 181).

By this law the willful trespassing on such lands during the summer and all months, is made a crime, and any constable or other officer may arrest the offender on the spot and take him before the proper tribunal for trial and sentence. But as to all other seasons of the year, or as to any other kinds of lands, such a trespass is only a civil trespass, not a crime, and the only legal remedy is by an action for damages done, which may be very unsatisfactory.

If, however, a man's object in coming into your premises is to steal your fruit, cranberries, or other crops, that itself is a crime, although he does not accomplish his purpose, and you may put him out by force, after notice to leave, using no unnecessary violence. But you cannot lawfully set spring-guns, man-traps, or other instruments which may do him grievous bodily harm without giving notice of such hidden dangers (4 Ping., 628; 37 Iowa, 613). The old school books in my early days had a picture of boys stealing fruit in the boughs of an apple tree, with a farmer picking up stones, and a maxim that if words and grass did not answer he might throw stones, but if you should happen to put out the boy's eye it might go hard with you, for you have not a right to kill even your neighbor's hens while scratching up your melons or cucumbers. The custom to do so, and toss the fowl over the fence, may afford some satisfaction to the gardener, but it may make him liable to pay the full value of the nuisance, although he had repeatedly warned their owner to keep them at home, or take the consequences (14 Conn., 1; 107 Mass., 406). Whether this rule applies to an old cat which is after one's chickens I don't know, but I mean to try it the first chance I have.

One of the most annoying forms of trespass to the farmer is that of hunting and fishing. Many persons seem to suppose that, by force of some general custom or otherwise, they have a right to hunt or fish over another's ground as they please, but this is quite erroneous (Pick., 145). In all ordinary streams and ponds the right to fish belongs solely to the person owning the adjoining land. If the stream is navigable, that, is, if the tide ebbs and flows, the public have a right to boat up and down, and to fish from their boats, but not to go on shore to do it. And by a very early law in Massachusetts, if a farm contains a "great pond"—*i. e.*, a pond containing over ten acres—the public have a right of fishing and rowing there, "and may pass and repass on foot through any man's property for that end, so they trespass not on any man's corn or meadow."

The recent laws authorizing Fish Commissioners to lease large ponds to private parties may, of course, modify the former rights of the public therein.

As to salt water fishing the law is somewhat peculiar, for although the owner of the upland ordinarily owns the land down to low water mark, as before stated, yet any other person may go there and dig clams or other shell fish, if he can do so by water, and without crossing the upland in going or returning (8 Cush., 347; 7 Gray, 440). The Legislature may sometimes abridge or modify this right, but the ordinary rule is as above stated.

FINALLY.

The question often arises, Who owns the fruit of a tree standing near the boundary line between two proprietors? It is generally supposed that the fruit on the limbs overhanging one's land belongs to him, but this is an entire mistake. If a tree stands wholly on your land, although some of the roots extend into the soil of your neighbor, and derive support and nourishment from his soil, he has no right to any of the fruit which hangs over the line (11 Conn., 177; 38 Vt., 105; 25 N. Y., 126). And if he attempts by force to prevent you from picking it, he is liable for an assault and battery (46 Bart., 337; 48 N. Y., 201).

In one instance a lady, while standing on the fence picking cherries which hung over the line, was forbidden to do so by the adjoining owner, who was at work in his garden, and in the scuffle to prevent her she received some bruises on her arm, for which he had the pleasure of paying the neat little sum of $1,000! If your fruit falls into your neighbor's lot you have an implicit license in law to go and pick it up, doing him no unavoidable damage (113 Mass., 376; 12 Vt., 273).

If, however, a fruit tree stands directly in the division line, and is what is called a "line tree," both parties own the tree and fruit in common, and neither can cut down the tree or seriously injure it without being responsible to the other (12 N. H., 454; 34 Bart., 547; 25 N. Y., 123).

Sometimes persons are tempted to poison or secretly kill a neighbor's tree of some kind which stands near the fence and casts a baneful shade on their garden plat, but this is dangerous business, and the party doing so may possibly find himself inside the county jail, where the rooms are apt to be small and not always very clean. The safer way in such cases is to cut off the limbs which hang over your side, which undoubtedly you have a legal right to do; but it would not be safe to use the limbs for firewood or otherwise convert them to your own use, lest you have to pay their value, more or less. I have thus imperfectly touched upon some of the leading rights and liabilities of farmers, and if, in the brief time allotted me, I have been able to impart any valuable information, or save you from the many entanglements of the law, or even to interest you but for the passing hour, my purpose has been accomplished.

FERTILIZERS FOR CORN.

AT a recent farmers' meeting at Concord, N. H., the principal address was by Prof. Atwater, of Middletown, Conn., on "Fertilizers" for corn. He spoke without notes for an hour and a half, and went over the subject very thoroughly. It was so full of meat that I feel incompetent to do it justice in the space that I have at disposal. He commenced with what he called a short lecture on chemistry, which I will not report as it is what every farmer should know, and if he does not know the difference between organic and inorganic matter, between alkalies and acids, between nitrogen and gypsum, or, if he does not know the meaning of the more common chemical terms, he should invest a dollar in Waring's "Elements of Agriculture" and study it these winter evenings.

Knowing that there are still farmers who believe that crops cannot be grown on chemicals, he gave the results of some experiments in water culture made in Germany. The seeds were sprouted in earth, and then the roots placed in glass jars filled with water, in which had been dissolved all the elements that were required by the plant. The plants made a good growth; in fact, attained a size and beauty that we seldom see equaled in field culture. Some of the grain reached a height of eight feet, and one plant had almost eight hundred perfect seeds, and this on nothing but water and chemicals. This shows that if land contains the proper food for the plant in an available form, one may expect bountiful harvests. One more experiment: when connected with the Experimental Station, the speaker took sand from the Wallingford plains, on which there is no sign of vegetable growth, and over which the sand blows in summer as does the snow over our New Hampshire farms in winter. He filled boxes with it, supplied the chemicals, and obtained a crop. Hundreds of experiments like these have been made, and they ought to convince any one that chemicals are plant food.

The farmer must think and investigate for himself; he must study his soil and experiment. All soils contain more or less fertility, and tillage is one of the best means of bringing it out. Looking from a chemist's standpoint, I think farmers do not cultivate their crops enough. Tillage is manure, for it brings the soil into contact with the air, and the elements are thus made soluble. If you put granite into water, a little will dissolve; add carbonic acid, and more will dissolve. Now, if we cultivate often, the soil is acted upon by the water, combined with the carbonic acid of the air, and fertilizing elements are released.

The chemist may analyze the soil and be able to find elements that the plant cannot; in other words, they are not available. The soil has been thought to be like a cistern, from which you dip until it is dry; but it is more like a well, into which the water is slowly running, for the soil is all the time undergoing changes that increase its fertility. I have sometimes thought that soils were like some men; they don't seem to amount to much, but if you treat them properly, and give them a chance to develop, you will be surprised to see what they are capable of doing.

The speaker here remarked that he should like to talk an hour on the treatment of farmers' boys, but must leave that subject for another time. When the land was new, it was not so absolutely necessary for the farmer to pay so much attention to the fertilization as it is now. While stable manure is a complete manure, it contains more of certain elements than others. Thirty or forty years ago, farmers found that their land was becoming deficient in phosphoric acid. About that time, the fossil and mineral phosphates of South Carolina and Canada were discovered. A few years later, they found that their soil was becoming deficient in potash; the soapman was taking all the ashes. How was that want to be supplied? A Frenchman constructed an apparatus for evaporating sea water; but that did not pay. But in past ages, nature had done that same thing; and about this time, the potash beds of Germany were brought to light. Covering, as they do, an area of over sixty square miles, and in some places reaching a depth of one thousand feet, they may be said to be exhaustless.

The nitrogen question is the hardest problem at present that the chemist has to solve. Notwithstanding that it forms four-fifths of the air around us, it is the most costly element that the farmer has to buy. The question is how much nitrogen can the plant obtain from the air? The man that discovers a way to obtain it from the air, at a small expense, will be the greatest material benefactor that the world has ever produced. Knowing that our soil does not contain fertility enough to produce maximum crops, we must apply some kind of fertilizer. In manuring, we should understand that the most economical manure depends on a number of different conditions. The most important factors are: first, the soil; second, the climate and season; third, the feeding capacity of the plant that we are to grow; fourth, tillage; fifth, chemical composition of the plant; sixth, the composition of the manure.

If you should ask me, as a chemist, what elements your soil wants, I should say I don't know, and all the way I can tell is by experimenting on it with different elements, and you can do that as well as I. One great want of our agriculture is closer study and observation by farmers. To test this matter there were some experiments made last year under my direction by quite a large number of farmers in different parts of the country. I put up some fertilizers in the following manner:

EXPERIMENTAL FERTILIZERS.

No. bag.	Fertiliser used.	Furnishing valuable ingredients.
1.—	Nitrate soda.	Nitrogen.
2.—	Dissolved bone-black.	Phosphoric acid.
3.—	Muriate of potash.	Potash.
4.—	Nitrate of soda. Dissolved bone-black.	Nitrogen. Phosphoric acid.
5.—	Dissolved bone-black. Muriate potash.	Phosphoric acid. Potash.
6.—	Nitrate of soda. Dissolved bone-black. Muriate of potash.	Nitrogen. Phosphoric acid. Potash.

These bags were sent out in sets, and blanks with them for the experimenter to fill out. These blanks called for everything that is of importance in making an experiment. The plan was to apply a bag to one-tenth of an acre; the plots to be long and narrow, and to have manure, plaster, and nothing on plots between. These experiments were tried by about thirty farmers in nearly every State in the eastern section of our country. About twenty-five have made a full report of their results, and they all show the truth of what I have said—that every man must experiment for himself. I will give you the yield of corn per acre of each bag; remember that it is the average of twenty-five experiments, and that they were applied to all kinds of soils, good, bad, and indifferent.

Bag No.	Bush.	Bag No.	Bush.
1.—Yield per acre, .	30	4.—Yield per acre, .	40·3
2.— " " " .	34·5	5.— " " " .	43
3.— " " " .	32	6.— " " " .	47·6
Plaster, ...	29·4	Nothing, ...	24
Barn yard manure, per acre, ...			48

It was shown that a few soils wanted nitrogen, and a few potash, and on the remainder phosphoric acid was *the* thing to apply. In only one case did nitrogen seem to be the controlling element, while in some it apparently did no good at all.

The professor gave numerous examples of the different yields, but I must put it in few words. In one case, every plot that received phosphoric acid alone, or in combination, gave a good crop, while, without it, there was no crop. As a general thing, the crop rose and fell with the amount of phosphoric acid applied. On one farm every plot that received potash did well; without it no crop was obtained. In the twenty-five experiments reported, there are ten cases in which phosphoric acid was the regulating ingredient, and the crop was influenced but little by the other elements. Here are ten more in which phosphoric acid was effective, but its influence was not so marked. There were but three cases in which the phosphoric acid did not seem to be beneficial. In four or five, potash takes the lead, and in a large number of cases seemed to do good. On the whole, taking the experiments as they have been reported, the phosphoric acid paid best, potash next, while the nitrogen was last.

If you ask me what to use for the corn crop, I shall say I don't know, but if you put the question, I should say that 300 pounds of superphosphate and 200 pounds muriate of potash, costing between eight and nine dollars, gave, in these experiments, forty-three bushels of corn per acre.

I have said that my question, as a chemist, is how much nitrogen can the corn plant obtain from the soil and air. There were some elaborate experiments made under my direction, this year, for testing this question. The experiments were made for the purpose of ascertaining the capacity of the plant to get its food from the air and soil, and the effect of different fertilizers upon it with special reference to the nitrogen supply. Those who made these experiments took twenty-one plots of one-tenth of an acre each. Potash, phosphoric acid, sulphuric acid, and lime were furnished in the proportion contained in a crop of fifty bushels per acre on all the plots. Then, on part of the plots, one-third the nitrogen that a crop of fifty bushels would call for was applied; on others two-thirds, and on the rest all. The following results were obtained:

	Cost.	Interest over the others.	Loss.
One-third nitrogen ration, .	$5.00	$4.00	$1.00
Two-thirds " " .	10.00	6.00	4.00
Three-thirds " " .	15.00	7.00	8.00

The above calculations are made on the supposition that a bushel of corn, with the stover belonging to it, is worth eighty cents. Nitrogen was also applied in different forms, in dried blood, nitrate of soda, sulphate of ammonia, and Peruvian guano, and the result was the same. Nitrogen did not pay. Therefore I would not buy much of this costly element for corn.—*N. E. Farmer.*

DESTRUCTION OF INSECTS.—In Germany school children are instructed to distinguish the most common noxious from beneficial insects; also to collect and destroy the former. In one district (Segeberg) the number of May beetles taken by children the past season amounted to 14,196 kilogrammes (about 31,250 pounds), besides 500 pounds weight of the larvæ or grubs of the same insect. Taking the number of beetles to the kilogramme as 930, the total number will amount to over 13,000,000. This is a practical method of curtailing the ravages of the "white grub," and might be with benefit put to use in the United States, where insects of similar habits abound.

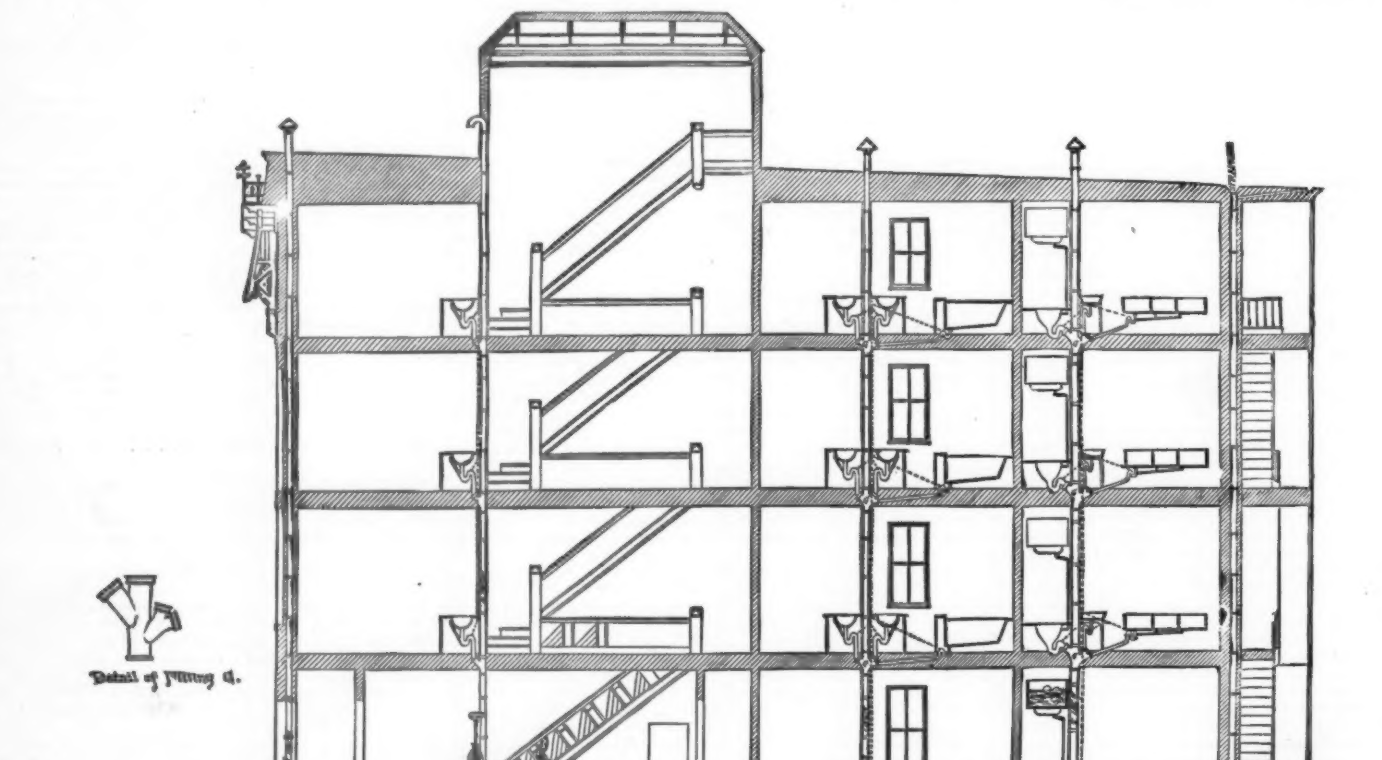
DRAINAGE OF AN APARTMENT HOUSE.

BEGINNING with the street front the double trap is placed on the main soil pipe as a security against back pressure from the sewer during a storm or high wind. These traps are placed at a point where they can be readily examined and cleaned. The vent shaft up the front wall is placed within the first of these traps, as it is not advisable to ventilate the sewer directly, particularly if there are adjoining houses with windows at a greater height than the top of the vent pipe, in which case any foul air would be wafted into them on occasions, and prove a nuisance.

A is a fresh-air or ventilating shaft, ending at an opening at the curb, having an open iron cover; it is also intended as a vent for gas when a column of water or solid matter is coming down the main pipes, and precludes the possibility of the traps up-stairs being forced by back pressure.

The vent shaft up the front wall should be four inches in diameter. Should the trap, D, be forced by back pressure—a contingency possible in many cities—it is supposed the sewer gas could find exit up this shaft easier than to force the second trap, E.

F is two-inch waste pipe, into which empties the wash basins, as shown. Each trap under wash basin should be ventilated by a pipe, as indicated by the dotted lines. If the trap is 1½ inch, this vent pipe should be not less than one inch, and larger if the basins are located a distance from a point where the vent reaches the fresh air. Some authorities claim that the vent should be the same size as the area of the trap.



DRAINAGE OF AN APARTMENT HOUSE.

It will be noticed that the basins and baths empty into a 3-inch waste pipe. The same rule should be observed in ventilating the traps here as that given above.

The fitting, G, we believe, is not yet obtainable from dealers, but doubtless our iron foundries will see the utility of it for work located as in this case, and will make patterns and supply the trade, who, we think, will admit that a better job can thus be made than by branching the basin pipe into the bath waste.

If the rain water pipe, H, were filled by the passing down of a column of water, or choked up, and both of the main waste pipes were in use passing down matter, the advantage of the vent pipe, A, would be seen; and its outlet being at the curb, no offensive smell could enter the house. It will be noticed that the main house waste passes along the cellar wall, where any defect or leakage could be easily discovered, and not, as in many cases, under the cellar bottom, which should never be allowed.

It will be noticed that in the system of drain pipes shown there are five unobstructed communications with the outer air. In these circulation would be kept up that will prevent the retention for any period of foul air within the house drains.

Cast-iron pipe and fittings of proper weight, free from sand-holes, should be used, and should be coated with coal tar, inside and out. Joints should be calked with oakum and molten lead, and all lead connection to branches should be by brass ferrules calked in a similar manner.

If this plan and these instructions are carried out, a house would, in our judgment, be practically safe from sewer gases.—*Plumber and Sanitary Engineer.*

A NUT FOR CONGRESS TO CRACK.

By P. H. WAIT.

A FEW years since two brothers, John and James, sons of an industrious poor man, set out in life with nothing but their hands, good health, and honest hearts. John chose to be a farmer, while James learned a trade. After a few years labor as hired men each had saved money enough to start business by himself.

John purchased 40 acres of government land, built a shanty, and commenced at once to improve his land. Finding the soil rich and fertile he was soon able to purchase another 40 acres adjoining it, into which he also energetically drove his plow. In the course of a few years he succeeded in obtaining two more adjoining lots, making his farm now number 160 acres, for which he holds four separate titles.

The land, now under thorough cultivation, is, with its improvements, valued at several thousand dollars.

James hired a small shop and commenced the manufacture of machinery, his works being driven by water power. The stream being small, and the wheel of the old primitive style, he was much troubled for want of power to do his work. To remedy this he set his wits to work; after much study, experiments, and several failures he succeeded in constructing a wheel, which, with the water he had, gave him abundant power. Having gained such signal victory over the old wheel, he sought and obtained a patent for his invention, and commenced the manufacture of this wheel as a permanent business. But as his invention was complicated and expensive he sought by careful study and experiment to lessen its cost. After spending much time and money in the effort, he succeeded in reducing its cost by nearly one third. This improvement, being an important one, was also covered by a patent.

Still finding only a limited demand for his wheels, and realizing but small profits from their sale, he sought to still further lessen their cost and to improve their working qualities so as to realize better profits and more lively sales. By adding new features, correcting errors, and by making extensive tests, he at length succeeded in working their manufacture up into a good paying business, upon which he now held four patents.

In the meantime John had added to his little farm until he owned a whole section of 640 acres, which he had nearly cleared, and for which he held six separate titles. Each of the boys having spent several years in improving his property had lived on a mere pittance, economizing at every point to obtain the means to support his family, while he toiled almost night and day to bring it into a paying condition.

At length, through energy, perseverance, and good luck they have succeeded, and are now enjoying the fruit of their labors. Each is receiving a fair income, and is laying up something for the rainy day.

But James sees a heavy cloud arising in the political horizon which may overshadow his future prosperity and swallow up the fruits of all these long years of privation and toil. There is a lot of pirates upon his track, who stand like hungry wolves watching their prey.

Too indolent to toil and build up a lucrative business, they are seeking to gobble up his rights, and to reap the benefits to themselves, but are at present held in check by the protection of the law.

They have applied to Congress, which now appears to be seriously considering the question of how to rob him of the titles which the government has granted to him.

It is not the honest laboring people who are so clamorous against patents, either outside or inside the doors of Congress. It is a set of political vampires, parasites, who never knew honest toil, but were reared and fattened on the blood of the people; wealthy corporations who are ever ready to grasp and to gobble up the hard earnings of the laborer and add to their ill-gotten store.

John is also surrounded by land sharks, who have a watchful eye upon his thrift. Like vultures they are waiting an opportunity to seize his goods. They had much rather squat upon his farm; plow and sow, or rather reap from his fruitful fields than to undergo the hardship of breaking up and subduing the wild lands around him.

Now, should Congress break the plighted faith of the government and levy the tax of one hundred dollars per year upon each of James' patents, it would be virtually placing a mortgage upon his property of nearly six thousand dollars, upon which he would be required to pay an annual interest of seven per cent. or give up the fruit of his hard-earned industry.

Now the question arises, Upon which of the two men should Congress levy the blackmail? Into which set of cormorants, pirates, or land sharks' hands should it play? Or, in other words, whose business shall it destroy? John has the best bargain. His titles are endless, while James' are only for a brief time, after which they will fall into the hands of the government and be free.

Would it not appear less ridiculous to divide the spoil between the two men, place a mortgage of say $3,000 upon each one's property, and collect the interest annually? This would give a new tone to the appropriation party in Congress, and supply a good subsidy fund for railroad and other poor corporations. But then there is an objection to this. James and John might be able to pay this amount to hold their titles, and the cormorants, sharks, pirates, knaves, and thieves would still be left out in the cold, and still have to be provided for.

Which is the most honorable, to hold to the faith of the government (about which the bondholders of late have been so eloquent) in its pledge to the former or to the inventor?

This history is a true one, with the names of the parties suppressed. The case is not an isolated one, but selected from among thousands of similar ones the country over.

EFFECT OF OCEAN CURRENTS.

As an illustration of the meteorological effect of ocean currents, Mr. J. K. Laughton lately called attention in a lecture to some estimates made by Mr. Croll of the heating influence of the Gulf Stream. He calculated that the surface water of the North Atlantic, if deprived of the Gulf Stream, would be reduced to a temperature very far below the freezing point, and that the heat which this great current disperses into the air above it, if converted into power, would be equal to the horse power of 400,000,000 of the largest iron-clad men-of-war.

EXPLOSIONS FROM COMBUSTIBLE DUST.*

By Professor L. W. Peck.

I wish to demonstrate to you this evening, by a few simple experiments, the fact that all combustible material when finely divided, forming a dust or powder, will, under proper conditions, burn with explosive rapidity.

If a large log of wood were united it might burn a week before being entirely consumed; split it up into cord wood and pile it up loosely, and it would burn in a couple of hours; again, split it into kindling wood, pile loosely as before, and perhaps it would burn in less than an hour; cut it up into shavings and allow a strong wind to throw them

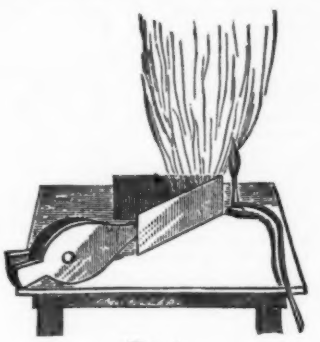


Fig. 1.

into the air, or in any way keep the chips comparatively well separated from each other, and it might be entirely consumed in two or three minutes; or finally, grind it up into a fine dust or powder, blow it in such a manner that every particle is surrounded by air, and it would burn in less than a second.

Perhaps you have noticed that shavings and fine kindlings will sometimes ignite so quickly in a stove that the covers will be slightly raised, the door forced open, or perhaps small flames will shoot out through the front damper. You have, in such a case, an explosion on a very small scale similar to that of the Washburn, Diamond, and Humboldt Mills of this city, on the night of May 2—upon which occasion the rapid burning of hundreds of tons of flour, bran, etc., completely demolished the solid-masonry walls, six feet thick, of the mills, and threw sheets of iron from the roof

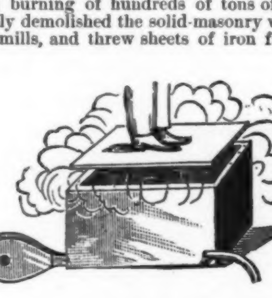


Fig. 2.

of the Washburn so high into the air that they were carried two miles by the wind before striking the ground.

Let us see now why such explosions occur. Wood has in it a large amount of carbon, the material of which charcoal is composed, and the air is about one-fifth oxygen. Now, at the ordinary temperature, the carbon of the wood and the oxygen of the air do not combine; but, when they are heated, as by friction, concentration of the sun's rays, chemical action as from a match, or in any other way, they combine to form carbonic-acid gas. This chemical action produces a large additional amount of heat which keeps up the action as long as there is any carbon and oxygen left to unite, and also makes the temperature of the gas which is formed very high.

As the space occupied by the carbonic-acid gas and that occupied by the oxygen which entered into the combination

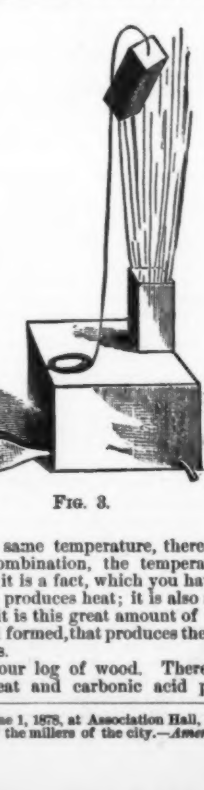


Fig. 3.

is the same at the same temperature, there would be no bursting if, after combination, the temperature were the same as before; but it is a fact, which you have all observed, that fuel in burning produces heat; it is also a fact that heat expands a gas, and it is this great amount of heat, taken up by the carbonic acid formed, that produces the immense pressure in all directions.

Let us return to our log of wood. There is exactly the same amount of heat and carbonic acid produced when complete combustion takes place in each of the cases of burning, the only difference being as to time. In the first case, the explosion or pushing aside of the surrounding air occupies a week, in the last only a second.

Snow-flakes fall gently upon your shoulders, and you are required to perform an insensible amount of work to resist the crushing effect of each flake; but suppose that all the snow that has fallen upon your head and shoulders for the last ten years was welded together in one solid mass of ice, weighing perhaps one hundred pounds, and that it should descend with the velocity of a snow-flake upon you, an immense effort would be required to prevent its crushing you, even if you were able to withstand the shock at all. The work of many days would be concentrated into an instant.

So it is with burning wood: four or five cords of wood, and a large stove, will give you a roaring fire all winter; the work done is manifested by the heat obtained, by the rushing of hot gases up the chimney, and of air from outside into the room through every crack. But, if the wood were ground into a powder and scattered through all the house, and burned instantly, the cracks, doors, windows, and flues, would not be sufficient to give vent to the hot gas, and the roof and sides of the house would be blown to pieces.

What is true of wood is also true of grains; also of vegetables, with their products when they contain carbon, with this exception: grain, either whole or ground, will not burn readily when in bulk. A fire could be built upon a binful of flour, and kept burning for half a day without igniting the flour; it would char upon the surface, but it lies in such a compact mass that the air does not get access to it readily, hence it does not burn.

I wish to show you now how combustible dust will burn when blown into the air by means of a pair of ordinary hand-bellows.

I have here two boards, about twelve by eighteen inches, nailed together, forming a V (see Fig. 1). Just outside of the V an ordinary Bunsen's gas-burner is placed, and within is a small handful of dust taken from a sash and blind factory. Upon blowing it smartly with the bellows a cloud is formed about fifteen feet high—extending, in fact, to the ceiling—which ignites from the lamp and produces a flash, very quick, and exceedingly *hot*, resembling very much a gunpowder flash. You will notice that a large amount of dust falls from all around the edge of the flame without burning; that is because it is not thick enough. Two things are necessary: first, that each grain of dust be surrounded with air, so that it can get the oxygen required *instantly;* and, secondly, that each grain shall be so near its neighbor that the flame will bridge over the space and pass the fire from particle to particle.

I think, after seeing the immense flame produced by such a small amount of fine saw and sand-paper dust, you will no longer wonder at the rapid spread of flames in furniture and similar factories. You know it is practically impossible to put out a fire after any headway is attained in these establishments; the draught produced will blow all the dust from

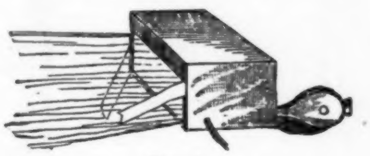


Fig. 4.

walls and rafters into the air, and the building in an instant is a mass of flame. Perhaps many of you remember the fire in the East-Side Saw Mills, a few years ago. Large masses of fine sawdust had probably collected upon the rafters, and the whole roof was perhaps filled with cobwebs loaded down with dust. A fire started from one of the torches used and shot through the mills with lightning-like rapidity, and, save for the fact that the ends and sides of the building were all open, there would have followed an explosion like that at the flour mills. As it was, the men had very great difficulty in escaping with their lives, notwithstanding that a short run in any direction would have taken them out of the mill.

It is very evident that too great care cannot be taken to keep all such factories and mills as free from dust as possible.

I will now blow some ordinary starch into the air in the same way, and you notice the flame is more vivid than in the last experiment, and, if you were in my position, you would notice that the heat produced is much greater. Notice now that this powdered sugar burns in the same way.

You will see from the experiments further on that three-quarters of an ounce of starch will throw a box, weighing six pounds, easily twenty feet into the air, and that half an ounce, burned in a box, will throw up the cover three inches with a heavy man standing upon it.

With these facts, which I have demonstrated before you, no one need regard as a mystery the Barclay street explosion in New York city, where a candy manufactory, in which large amounts of starch and sugar might in many ways be thrown into the air by minor disturbances, took fire and completely wrecked a building and destroyed many lives.

I will now burn in the same way some buckwheat, which, as you will observe, gives a very large blaze; now some corn-meal, which is too coarse to burn as well; now some rye flour, which burns much better than the corn; now some oatmeal, the finer part of which only burns; and so I might continue with all sorts of finely-ground vegetable material.

Let us take up now the products of the manufacture of flour from wheat. There were between three and four hundred tons of these materials, upon which I am now to experiment, in the Washburn Mill at the time of explosion, and there was a corresponding amount in the Diamond and Humboldt Mills, which, by their sudden burning, produced the second and third shocks heard directly following the explosion of the larger mill.

The wheat is first placed in a machine, where it is rattled violently and brushed. At the same time a strong draught of air passes through it, taking up all the fine dust, straw, etc., and conveying it through a spout to a room known as the wheat-dust room, or perhaps more commonly it is blown directly out of the mill.

You see some of this material here; it looks like the wood-dust of the first experiment, and, as you see, burns with a quick and sudden flash when subjected to the same conditions.

Here, then, we have the first source of danger in a flour-mill. A thick cloud of this dust, when conveyed through a spout by air, will burn in an instant if it takes fire; and, if there is any considerable amount of dust, as there would be if there were a dust-room, an explosion will follow which may become general if it stirs up a thick dust-cloud throughout the mill.

The wheat after it has been cleaned in this way goes to the crushers, which are plain or fluted iron or porcelain rollers, working like the rollers in a rolling mill. The object of these rollers is, I believe, to break off the bran in as large pieces as possible, and to crush out or flatten the germ so that it can be separated with the bran from the rest of the meal.

The crushed wheat goes now to the stones, where so much heat is produced (average 135° Fahr.) that a large amount of steam is formed from the moisture in the materials. This steam would condense in the meal and interfere with bolting, etc., if it were not removed. To effect this, another draught of air and another spout are employed, and, as might be expected, this current takes a large quantity of the very finest flour, called flour dust, with it. To save this, a room is provided near the end of the spout, called the flour-dust house. The spout conveying steam and dust enters this room on one side, and another spout opposite leaves it, passing to the open air. It is in this comparatively dead-air space that the dust settles, and can be collected from the floor. Here is some of this material, which, as you see, when blown into the air produces a vivid flash, extending from the table to the wall.

The evidence taken before the coroner's jury shows very clearly that it was this material that started the great explosion of May 2. Just how the mill took fire will probably never be known of course, but in all probability the stones either ran dry—that is, were without any meal between them—or some foreign substance, such as a nail, was in the feed, producing a train of sparks such as is produced by an emery wheel or a scissors-grinder's wheel. These sparks set fire to small wads of very hot dust, which, as soon as they were fanned into a blaze, communicated it to the spout and house full of dust. An eye-witness of the explosion first saw fire issuing from the corner of the mill where this flour-dust was situated, the end of the spout having probably been blown out. This fire was followed instantly by a quick flash, seen through all the windows of the floor upon which the flour-dust houses were situated, followed instantly by a flash in the second story, then the third, and, in rapid succession, fourth, fifth, and sixth stories; then followed the great report produced when the immense stone walls were thrown out in all four directions, and the roof and part of the interior of the mill shot into the air like a rocket.

It would seem that a blaze is necessary to ignite the mixture, for I have tried powerful electric sparks from a machine, and from a battery of Leyden jars; also incandescent platinum wire in a galvanic circuit, and glowing charcoal, without producing any fire, however thick the dust might be. Perhaps, however, under more favorable conditions, the dust would ignite directly from sparks, but it seems very improbable.

Let us continue now with the process through which the ground wheat is made to pass. From the stones it is conveyed to the bolting reels, where the very finest is sifted out first, and we obtain a grade of flour; after the finer material is sifted out it goes to a coarser bolt, where the "middlings," as it is called, passes through, leaving the bran which comes out at the end of the reel. The middlings, as it comes from the bolts, has fine bran and dust in it, and, to purify it, it is subjected to an operation similar to that of cleaning the wheat, that is, in the middlings purifiers it is subjected to a draught of air which takes away all the light bran and dust, leaving the heavier material (purified middlings), which goes again to the stones to be ground into flour.

Here is some of the dust from these "middlings machines;" you observe it burns as the other materials burned, quickly, and with intense heat.

Here is some of the purified middlings; each grain is comparatively large and heavy, making it difficult to blow it well into the air, but, as the blaze produced by each particle is quite large, a flash is produced which does not differ materially from the others.

Here is some of the general dust of the mill, that is, dust swept up from the floors, walls, beams, etc. You will see it acts in all respects like the other substances.

And, finally, here is some of the flour taken this afternoon from the flour-sack at home; it burns, you observe, if possible, with even more energy than the other kinds of dust.

I have performed a few experiments, which I will now repeat, which will illustrate to you the immense power that these materials exert when burned in a confined space.

This box (Fig. 2) has a capacity of two cubic feet; the cover has a strip three inches deep nailed around it, so that it telescopes into the box; there is in this lower corner an opening for the nozzle of the bellows, in this an opening for the tube to the lamp. I place now a little flour in the corner, light the lamp, and my assistant places the cover upon the box and steps upon it. Take notice that upon blowing through the hole, and filling the box with a cloud of flour, the cover comes up suddenly, man and all, until the hot gas gets a vent, and a stream of fire shoots out in all directions.

Here is a box (Fig. 3) of three cubic feet capacity, including this spout, nine inches square and fifteen inches long, coming from the top of it; at the ends doors are arranged closed like steam-boiler man-holes; openings for light and bellows are arranged as in the previous box.

Here is a box, weighing six pounds, that will just slip over the spout; it has a rope lest it should strike the wall after the explosion. Placing now the lamp in the box, some dust in the corner, and the box over the spout, we are ready for another explosion. You observe, after blowing vigorously for a second or two, the dust in the box takes fire; the box over the spout is shot off, and rises until the rope (about twelve feet long) jerks it back; it strikes the stage with great force, rebounds and clears the footlights, and would strike the floor below were it not for the rope.

I have thrown a box similar to this in the open air twenty feet high, while, as we shall see presently, less than an ounce of flour is being consumed.

I have fastened over the top of the spout five thicknesses of newspaper; upon igniting a boxful of dust as before, the paper is thrown violently into the air, accompanied by a loud report as it bursts.

For the last experiment I have a box of four cubic feet capacity (Fig. 4), five sides are one and a half inches thick, the remaining side one-quarter inch. Upon igniting the dust in this box, filled as in the other cases, the quarter-inch side bursts, and a stream of fire shoots out half way across the stage.

One pound of carbon and two and two-thirds pounds of oxygen, when they combine to produce carbonic acid, will evolve heat enough, if it were applied through a perfect heat

* Lecture delivered June 1, 1878, at Association Hall, Minneapolis, Minnesota, at the request of the millers of the city.—*American Miller.*

engine, to raise 562 tons ten feet high; if, therefore, forty per cent. of flour is carbon, it would require two and a half pounds to accomplish this result, if an engine from which there would be absolutely no radiation, conduction, or loss of heat, in any way, were a practical possibility. Let us see how much air would be required to supply oxygen enough. Under ordinary conditions every 100 cubic inches of air contains 7·13 grains of oxygen, from which we find that 151½ cubic feet of air would be required for the 2⅜ pounds of oxygen. Hence the 2½ pounds of flour must be equally distributed as a dust through 151½ cubic feet of air, in order to produce the most powerful result.

If forty-one ounces of flour requires 151 cubic feet of air for perfect combustion, one cubic foot of air will supply oxygen enough for 40-151 of an ounce of flour. Hence our box, which lifts the man so readily, burns half an ounce of flour or less; and the other, which throws the box into the air, three-quarters of an ounce, unless, as I think quite probable, an additional amount of air is drawn in through the cracks as soon as the vent is opened at the top of the box. In fact, these experiments work better if a few small holes are made near the bottom of the boxes.

It may be worthy of mention here, as a point of interest to insurance companies, that in all dust explosions, a fire precedes the explosion in every case. The dust must burn before the heat that produces the immense expansive force is generated.

Too great precaution cannot be taken in all kinds of manufactories, where combustible dust is produced, against fire, especially in those establishments where it is conveyed in thick clouds by air draughts through spouts and rooms.

IMPROVED CARDING MACHINE.

THE accompanying engravings represent an improved wool carding machine constructed by the Messrs. Pierrard-Parfaite, of Rheims, France. To this firm gold and silver medals were awarded at the Paris Exhibition for machinery for wool manufacture.

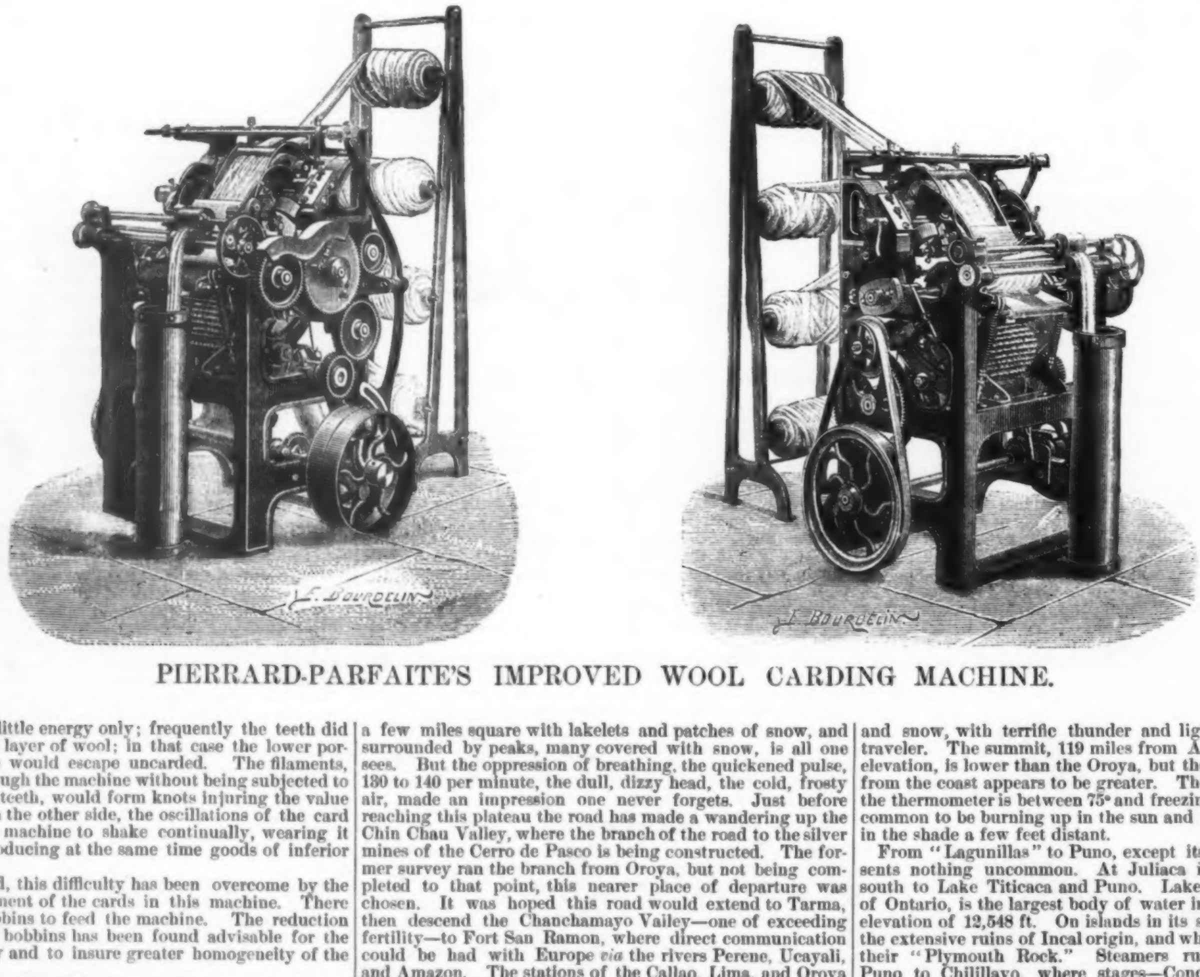
These machines are simple in construction, durable, easily regulated and cleaned. They differ from the ordinary machines principally by the arrangement of the cards. Of the latter there are two, as in the old machines, but, while in these one had an oscillating, the other a rotary motion, they are, in the Pierrard machine, both stationary and rotary.

These oscillations of the cards in ordinary machines were performed with little energy only; frequently the teeth did not penetrate the layer of wool; in that case the lower portion of the same would escape uncarded. The filaments, passing thus through the machine without being subjected to the action of the teeth, would form knots injuring the value of the wool. On the other side, the oscillations of the card caused the entire machine to shake continually, wearing it out soon, and producing at the same time goods of inferior value.

As above stated, this difficulty has been overcome by the peculiar arrangement of the cards in this machine. There are only four bobbins to feed the machine. The reduction of the number of bobbins has been found advisable for the sake of simplicity and to insure greater homogeneity of the carded wool.

When worn out, the cards may readily be removed and replaced by new ones.

These machines may of course be also used for cotton and other textile fibers.



PIERRARD-PARFAITE'S IMPROVED WOOL CARDING MACHINE.

[Continued from SUPPLEMENT No. 165.]

THE WONDERFUL RAILWAYS OF PERU.

Lima and Callao Railroad.—Landing at Callao, on your right, are the station and offices of the Lima and Callao Railroad. On the left, the wonderful "Oroya Railroad." The former, built twenty-nine years ago by Peruvians, was bought by an English company. From Lima to Chorillos —the Brighton or Long Branch of Peru—is another railway, costing, with the Lima and Callao road, $12,000,000. Both lines are under one control, and pay their English owners 12 or 13 per cent. on a capital of $4,000,000, which is now their assessed value. The rolling stock of these roads, until their twenty-fifth year exclusive right was finished, was very bad, and traveling uncertain. Trains started at fixed times or "thereabouts," which meant half an hour to four hours from schedule time.

The Callao, Lima, and Oroya Railroad, generally known as the Oroya Railroad, now the Transandine Railroad, is probably the most wonderful railroad in existence. It was contracted for by Henry Meiggs in 1869, at a cost of $21,804,000, or $27,000,000 in bonds. Work was begun in January, 1870. When commenced the English company had yet the right of way from Callao to Lima, and Mr. Meiggs could get no special rates for his material. The enormous cost of freighting everything for his road would make it ruinous to build. One day suddenly appeared hundreds of men evidently making a railway from Lima to Callao. The English company went to see about it, and then got out an injunction to stop the work. Mr. Meiggs calmly asked them whose land the workmen were on, and then they found he had quietly bought up all that land and was building a private road on his own grounds and for his own use. Leaving Callao the road to Lima is in the finest condition. Ballasted with cobble stones, no dust arises; trains every half hour; fare 40 cents; four separate depots accommodate different parts of the city. No one who makes a round trip on this road ever repents it, and seldom desires a second. The heights and distances are so great that few heads are not affected. From San Mateo to Anchi the road passes through the "Infernillos"—Little Hell. Nearly perpendicular walls from 2,000 ft. to 3,000 ft. hem in the river Rimac, having a width of from 200 ft. to 400 ft. At first it was proposed to make a cut in the side of these mountains, but, fearing the falling of loose rock, it was decided to tunnel. Miners were let down with ropes, one-quarter and one-half mile long, to certain indicated points on the rocky wall every 500 feet, more or less, and after they had entered a few feet began working to the right and left, using the entrance as a place from whence to throw the excavated material. About midway a bend in the river made it necessary either to make a dangerous curve or span the chasm. The latter was chosen, and now a bridge unites the tunnels about 400 ft. above the river bed. Emerging from the second of these tunnels at Anchi, the Rimac is recrossed, and the road follows up the river Blanco a few miles, which it crosses, and then enters a mountain, where it turns around in a curved tunnel, and, emerging a few hundred feet above, recrosses the river and returns, passes Anchi, and continues up the river Rimac. At Chicla, a few miles further, the road passes the town, returns, crosses its own track and the Rimac, turns and passes again, and, reversing, returns and again doubles on itself, having passed Chicla five times. The view from the summit, 15,568 ft. at the entrance to the Galera tunnel, is not so imposing as at other points. A plateau of a few miles square with lakelets and patches of snow, and surrounded by peaks, many covered with snow, is all one sees. But the oppression of breathing, the quickened pulse, 130 to 140 per minute, the dull, dizzy head, the cold, frosty air, made an impression one never forgets. Just before reaching this plateau the road has made a wandering up the Chin Chau Valley, where the branch of the road to the silver mines of the Cerro de Pasco is being constructed. The former survey ran the branch from Oroya, but not being completed to that point, this nearer place of departure was chosen. It was hoped this road would extend to Tarma, then descend the Chanchamayo Valley—one of exceeding fertility—to Fort San Ramon, where direct communication could be had with Europe *via* the rivers Perene, Ucayali, and Amazon. The stations of the Callao, Lima, and Oroya Railroad are Callao to Lima 7½, Quiroz 11¾, Santa Clara 18¼, Chonica 33¾, Cocachacra 44¾, San Bartolome 46¾, Surco 55¾, Matucana 62¼, San Mateo 77½, Youli 119, Oroya 136. The rise from San Bartolome to the summit is almost all the way 4 ft. to every 100 ft. From the summit to Oroya is a descent of 3,390 ft., the steepest being from the tunnel to Youli. From Oroya the road is now being extended ninety miles northward to the famous silver region of Cerro de Pasco.

Lima and Pisco Railroad.—A contract was granted to the Ramos Brothers to build a railroad under this title southward along the coast from Lima, 145 miles in length, at a proposed cost of $9,400,000, incomplete.

Pisco and Ica Railroad.—This road, forty-eight miles long, cost $1,450,000. It passes through the vineyards of "Chincha alto" and "Chincha bajo" over rich fruit and agricultural lands to Ica. In front of Pisco are the Chincha or Bedbug guano islands. Pisco is famous for a clear, transparent brandy called Pisco, and another called Italia, made from the Italian grape. This road is rented for five years by the Government for $80,000 for the first two years and $105,000 for the last three years.

Mollendo and Arequipa Railroad.—Eighteen miles south of the port of Islay the river Tambo empties into the Pacific at Mejia Point. This was to be the landing place for the Mejia and Arequipa Railroad. Owing to it being often too dangerous to pass the surf, Mr. Meiggs conceived the idea of extending the line down the coast to Islay. Certain parties foreseeing this, bought up the land, and when he tried to purchase asked such exorbitant prices that he could not afford it, and, stopping nine miles south of Islay, made a landing in a crevice of the rock coast at a place called Mollendo. The road is now called the Mollendo and Arequipa Railroad. This and its continuation under the name of Arequipa and Puno Railroad and Juliaca and Cuzco Railroad is next in wonder to the Oroya, the stupendous work at the Infernillos only making the latter more remarkable. From Islay southward it runs to Mejia, then turning eastward, begins winding around the points of mountains and then up ravines; beginning five miles from Mejia to gain elevation, it also begins its windings.

At Cahuintala ravine the road becomes very remarkable. Three trains are often seen here one above the other. A cool head and steady nerve and close attention are needed by every engineer at this point. Reaching the Pampa of Cachendo, an extensive barren plain stretches as far as the eye can see, bounded in the distance by mountain peaks. The crescentic sand dunes hold their sway, and the heat from the polished pebbles causes many an inflamed eye. Till the railroad was built this was like the Arabian Deserts to cross. Many each year, lost and confused, laid down their lives on this plain. Even the civil engineers needed their utmost skill to find their way over the trackless desert.

Seventy miles from Mejia the road descends to the bank of the river Chile, which stream it follows to Arequipa, distant from Mollendo 107 miles, an elevation above the sea 7,560 ft. Begun May 27th, 1868, it was finished December 24th, 1870, with great festivities, and cost $12,000,000.

Arequipa, a city of 135,000, is the second city of the republic. At the foot of the volcano, "Misti," it has many times been in ruins. In 1868 it was nearly destroyed. From Arequipa the Arequipa and Puno Railroad takes its origin, 217 miles long, cost in bonds $32,000,000, in gold $25,280,000. Its windings and climbings, cuts and fills, are extensive, from 140 ft. in height and 500 ft. long to 50 ft. Want of water, it having to be carried on mules, made the first part difficult to build.

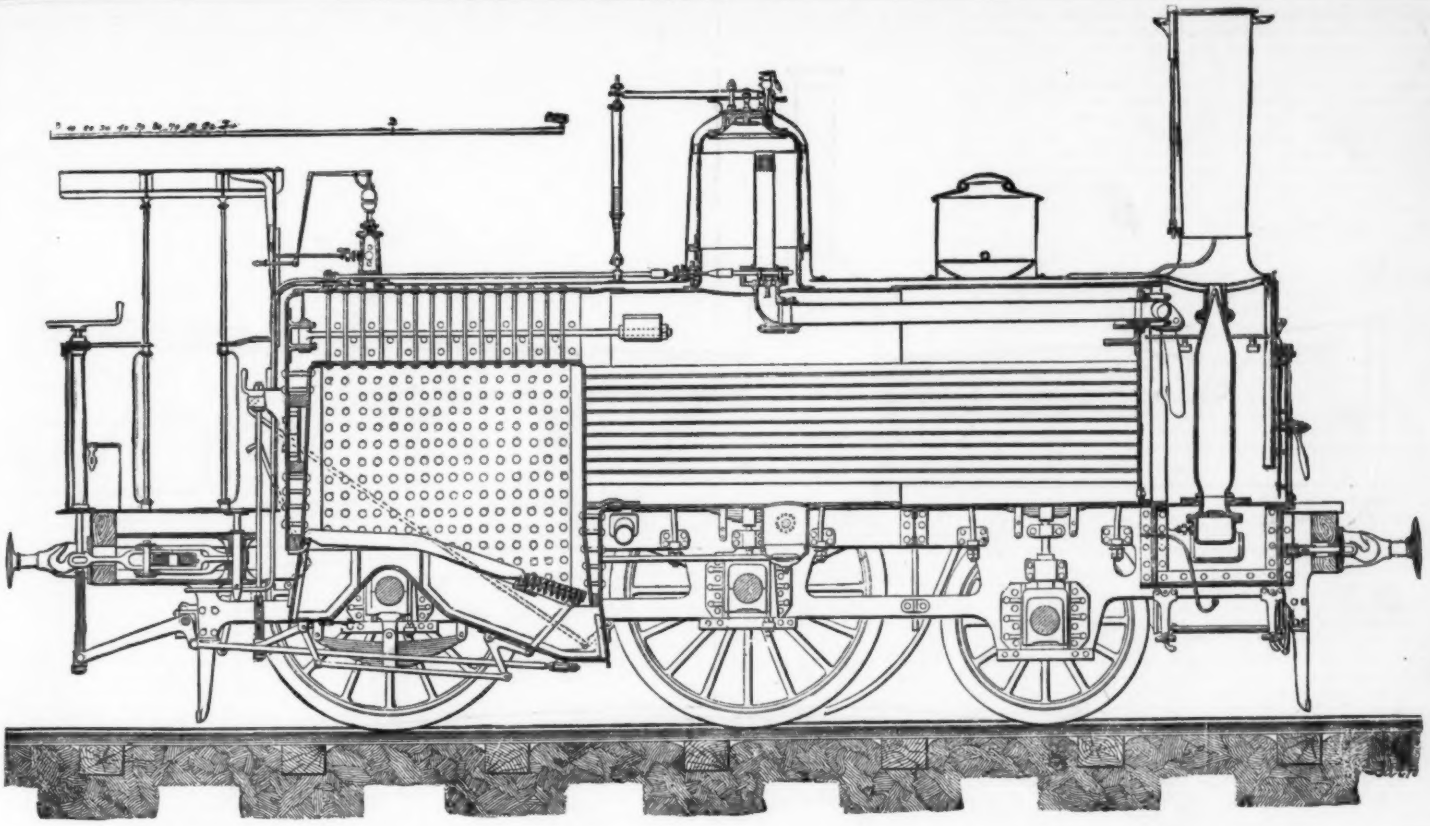
From the hot springs, "Aguas Calientas," the ascent is rapid to Chanaquos, and a corkscrew is straighter. Between Lumbay Bridge and the little lakes beyond the summit hail and snow, with terrific thunder and lightning, salute the traveler. The summit, 119 miles from Arequipa, 14,667 ft. elevation, is lower than the Oroya, but the climatic change from the coast appears to be greater. The average range of the thermometer is between 75° and freezing, and it is not uncommon to be burning up in the sun and freezing going on in the shade a few feet distant.

From "Lagunillas" to Puno, except its elevation, it presents nothing uncommon. At Juliaca its course is nearly south to Lake Titicaca and Puno. Lake Titicaca, the size of Ontario, is the largest body of water in the world at the elevation of 12,548 ft. On islands in its southern part exist the extensive ruins of Incal origin, and where history founds their "Plymouth Rock." Steamers run regularly from Puno to Chilillayo, where stages—Concord, American—connect with La Paz, the capital of Bolivia.

Juliaca and Cuzco Railroad.—From Puno to Cuzco, 140 miles north, an extensive plain, rich in minerals, metals, and pasturage, made a railroad less difficult of construction, yet it was estimated at $25,000,000. Difficulty of labor at elevations above 12,000 ft. increased the cost; 120 miles are finished. Since Juliaca was 28 miles in direct route to Cuzco, the road took that as its starting point, and is called the Juliaca and Cuzco Railroad. These three lines were contracted by Henry Meiggs, two being finished.

Ilo and Moquegua Railroad.—South of Mollendo, from the port of Ilo, a railroad is finished to Moquegua, 63 miles distant. Cost $5,025,000; H. Meiggs, contractor. The road is not paying expenses. Moquegua is the great grape country of Peru, and the Moquegua wine as celebrated as the Italia and Pisco brandies.

Arica and Tacnar Railroad.—Further south is Arica, the ill-fated. Ruined in 1868 by the tidal wave, it had but partially recovered when the 9th day of May, 1877, again submerged it. In 1852 Joseph Hegan signed a contract to build a railroad from Arica to Tacnar, 39 miles. It ran along the coast, turning east and north to Tacnar. In 1853 he sold his contract to an English company which had a capital of $2,000,000. Although Bolivia has a seaport, Cobija, Arica



NEW SIXTEEN TON TANK LOCOMOTIVE.—SCHNEIDER & CO., ENGINEERS, CREUSOT

is nearer and a better place of starting than her ports. Until the Mollendo and Arequipa, and Arequipa and Puno railroads united the lakes with the coast, most all Bolivian imports and exports passed through Arica.

Iquique and La Noria.—Still south is the port of Iquique. From this point the Iquique and La Noria Railroad and branches could better be called railroads from Iquique and Tarapaca, all this region being an extensive nitrate of soda plain; 180 miles of railroad connect the salitra works at La Noria, Cocina, Altagracia, Yungay, Negreros, Lagunas, Pampa Negra, Chinquinquiray, Sal de Obispo, Zapiga, La Pena, and others with the coast. In eleven months of the year 1872 the exports of nitrate of soda amounted to 3,983,798 cwts.

The grounds cover fifty square leagues. The water used is distilled from the sea, and an every-day sight in the streets of Iquique is a boy, woman, or man with a keg rolling behind him drawn by a rope noosed over screws in each head. You watch the train leave, and see it reach the foot of the sand hills, then turn to the left and ascend by a side cutting about a third of the height, and then running in the opposite direction, it is lost to sight over the mountain of sand. One hour the train is in sight; thence to the nitrate centers, where water is scarce, and heat, dirt, and discomfort abound.

Patillos and Lagunas Railroad.—Provost & Co. built, at a cost of $1,000,000, a railroad from Patillos to Lagunas, 90 miles, the most southern nitrate region of Peru, and on her borders. Thus hastily we have reviewed the railroads of Peru, which, owing to the climate, elevation, want of material, difficulty of transportation, and short time, compare with other countries of more extent and wealth. One can obtain little idea of these roads in reading of them. It is necessary to see the tremendous engineering achievements, to feel the rare air, the sensation of great heights, to understand why these are so wonderful. Every tourist returning from these roads, the "Oroya," "Arequipa," and "Puno," can but admire the courage of a man willing to undertake such works. A trip to South America and a visit to these three railroads will interest more than a journey to Europe.

NEW FRENCH TANK LOCOMOTIVE.

IN the Creusot pavilion was to be found a locomotive engine, exhibited by MM. Schneider et Cie., which deserved more attention than it apparently received. At the first glance the visitor would be disposed to conclude that it was an ordinary side tank engine, not more handsome than such engines usually are; but closer examination, aided by a little information imparted by the makers, would suffice to prove that it was in many respects the most remarkable engine in the Exhibition. In the matter of finish it surpassed perhaps anything that has yet been produced in an engineer's workshop, and the notice hanging on it, stating that the bright work was not nickel plated, was by no means superfluous. Every polished surface was polished like a mirror, and the closest examination failed to detect the smallest trace of seam, or flaw, or speck in the metal. Nor was this the only noteworthy feature about the engine. It weighed less for its dimensions than perhaps any other tank engine recently built. Our readers experienced in locomotive construction will find it difficult to believe that an engine with 16 in. cylinders, 23 in. stroke, 5 ft. 3 in. wheels, and carrying some 800 gallons of water, could be made to weigh, full, rather under 16 tons; but that is stated by Messrs. Schneider to be the weight of the engine; and if our readers will turn to the illustration we publish this week, they will see that the proportions of the engine are such as are consistent with the statement of the weight we have just given. The truth is that this may be regarded as almost a steel locomotive—an engine, in short, made of perhaps the finest materials ever worked up to such a purpose, and of which materials not a superfluous pound has been used.

It may be said that nothing is gained by making a locomotive light; that it must be heavy to secure adhesion. But this depends on the nature of the traffic which it is called upon to work. The tractive force of MM. Schneider's engine is about 93 lbs. per pound average effective cylinder pressure. This last can hardly ever exceed 90 lbs. on the square inch, giving a gross tractive effect of 8,370 lbs. Now, the weight on the four-coupled wheels is 23,360 lbs., and, with the aid of sand, the coefficient of adhesion may be brought up to one-third of the load, or to, say, 7,787 lbs. It is clear, therefore, that the engine could be made to slip its wheels at any time; but so long as the load does not exceed that which will produce a resistance of about 4,000 lbs., the engine will not slip. In other words, it would be able to take a gross load of about 200 tons up an incline of 1 in 224, at, say, twenty miles an hour. But in the service on which this engine is actually employed the loads are nothing like this, and the engine is therefore well up to its work, and because of the absence of weight it can be run on a very light road, while the large boiler and cylinders enable fuel to be used with economy. So that, taking all things into consideration, there is, we think, much about the design to commend it to all engineers interested in light railways.

The engine is one of several specially designed for working the traffic on the Dombes and Southeastern Railway. It is specially intended for passenger service, running at a speed of 25 to 30 miles an hour over lines full of curves of short radius. The cylinders are outside, and the trailing axle placed under the fire box. The tanks are arranged on each side. The grate, as will be seen from the annexed table of dimensions, is of very large size, made of very thin bars, placed close together, and well adapted for burning small coal. The front part of the grate is sharply inclined to keep the fire away from the tube ends. The four coupled wheels have been forged in the same presses, and are identical with one another. To permit the free passage of the engine round curves the leading axle boxes have a side play of about ¾ in. in the horn plates, and they receive the pressure of the springs on inclined planes in a way which will be so easily understood that we need not describe it. The feed water is supplied by two injectors with fixed cones, Nos. 9 and 7; they deliver into a drum placed under the cylindrical portion of the boiler. This arrangement facilitates the examination of the clack boxes. A screw brake is provided, and also one of Harmignies' back pressure brakes. The exhaust pipe is fitted with a spring valve, which can be worked from the foot plate, so as to close the exhaust pipe or leave it open. The same movement opens or closes a small cock, through which water can be admitted to the cylinders. The brake is applied in the usual way, by opening the regulator and putting the engine in back gear. The spring valve to which we have referred prevents smoke and ashes being drawn into the cylinders by any chance. The breeches pipe of the exhaust is fitted with a man-hole, by means of which access can be had to the back pressure valve.

We give the principal dimensions of the engine in the nearest English equivalents of the French measures in the following table:

Boiler:		
Length of grate	5 ft.	8 in.
Width of grate	3 ft.	3¼ in.
Area of grate in square feet	18⅞ ft.	0 in.
Height of crown in front	4 ft.	8⅞ in.
Height of crown at back	3 ft.	7¾ in.
Length of outside fire box	6 ft.	2¾ in.
Width of outside fire box	3 ft.	10¼ in.
Diameter of barrel	4 ft.	1⅝ in.
Length of barrel	13 ft.	5½ in.
Height of center of barrel above rail	6 ft.	4¾ in.
Tubes, number	181.	
Length of tubes	10 ft.	10 in.
Diameter of tubes outside	0 ft.	1·811 in.
Heating surface of fire box, square feet,	85	
Heating surface of tubes	887	
Total heating surface	972	
Working pressure	128 lbs.	
Internal diameter of chimney at top	1 ft. 6½ in.	
Internal diameter of chimney at bottom	1 ft. 3¾ in.	
Height of top above rail	13 ft. 11 in.	
Engine:		
Maximum opening of regulator, square inches	18·6 ft.	
Diameter of steam pipes, one to each cylinder	0 ft. 4 in.	
Distance from axis to axis of slide valves	6 ft. 9⅝ in.	
Angle of advance of eccentric	30 deg.	
Maximum admission in percentage of stroke	80.	
Minimum admission in percentage of stroke	12.	
Outside lap	1·024 in.	
Inside lap	0·079 in.	
Radius of eccentric	2·165 in.	
Travel of slide valve	4·33 in.	
Length of steam port	11·81 in.	
Breadth of steam port	1·49 in.	
Length of exhaust port	11·81 in.	
Breadth of exhaust port	2·59 in.	
Length of slide valve	9·528 in.	
Breadth of slide valve	14·560 in.	
Distance from axis to axis of cylinders	6 ft. 1¼ in.	
Diameter of cylinders	16·14 in.	
Stroke of piston	23·622 in.	
Diameter of piston rod	2·52 in.	
Length of connecting rod	4 ft. 11⅝ in.	
Section of connecting rod at small end	1·732 in. by 2·992 in.	
Section of connecting rod at big end	1·73 in. by 3·543 in.	
Diameter of crosshead pin	3·150 in.	
Length of crosshead pin	2·913 in.	
Diameter of crank pin	4·72 in.	
Length of crank pin	4·72 in.	
Frames and wheels:		
Length of side frames	23 ft. 5¾ in.	
Least depth of side frames	0 ft. 10¼ in.	
Thickness of side frames	0·984 in.	
Diameter of coupled wheels	5 ft. 3⅜ in.	
Diameter of leading coupled wheels	3 ft. 11¼ in.	
Total wheel base	12 ft. 9½ in.	
Diameter of journal of driving axle	6·69 in.	
Length of springs	2 ft. 11⅜ in.	
Breadth of leaves	0 ft. 3½ in.	
Thickness of leaves	0·47 in.	
Number	12.	

The right-hand tank holds about 480 gallons, and the left-hand tank about 360 gallons, or about 840 gallons in all. The bunker in the foot-plate end of the left-hand tank holds about 7 cwts. of coal. The total weight of the engine when full is a little under 16 tons; of this the leading wheels carry about 5½ tons and the driving wheels 5 1-3 tons.—*The Engineer.*

SOME idea of the influence of railways on the increase of the town populations of Germany may be gathered from the following figures, which show the growth of towns having the advantage of railway communication. Of 2,528 towns of over 2,000 inhabitants, only 867, in the year 1867, were provided with a railway. In 1871 there were 1,049, and in 1875, 1,270. In the course of these eight years the total population of 2,528 towns rose from 8,848,000 to 12,424,000. Of 1,837 towns of from 2,000 to 5,000 inhabitants, in 1867 there were 1,388 without any railway communication. In 1871 they had fallen to 1,263, and in 1875, to only 1,005. Of 591 towns of from 5,000 to 20,000 inhabitants in 1867, 208 were without railways; in 1871, 213; and in 1875, only 162; while those provided with railways increased from 323, with a population of 2,759,000, to 429, with a population of 4,000,000.

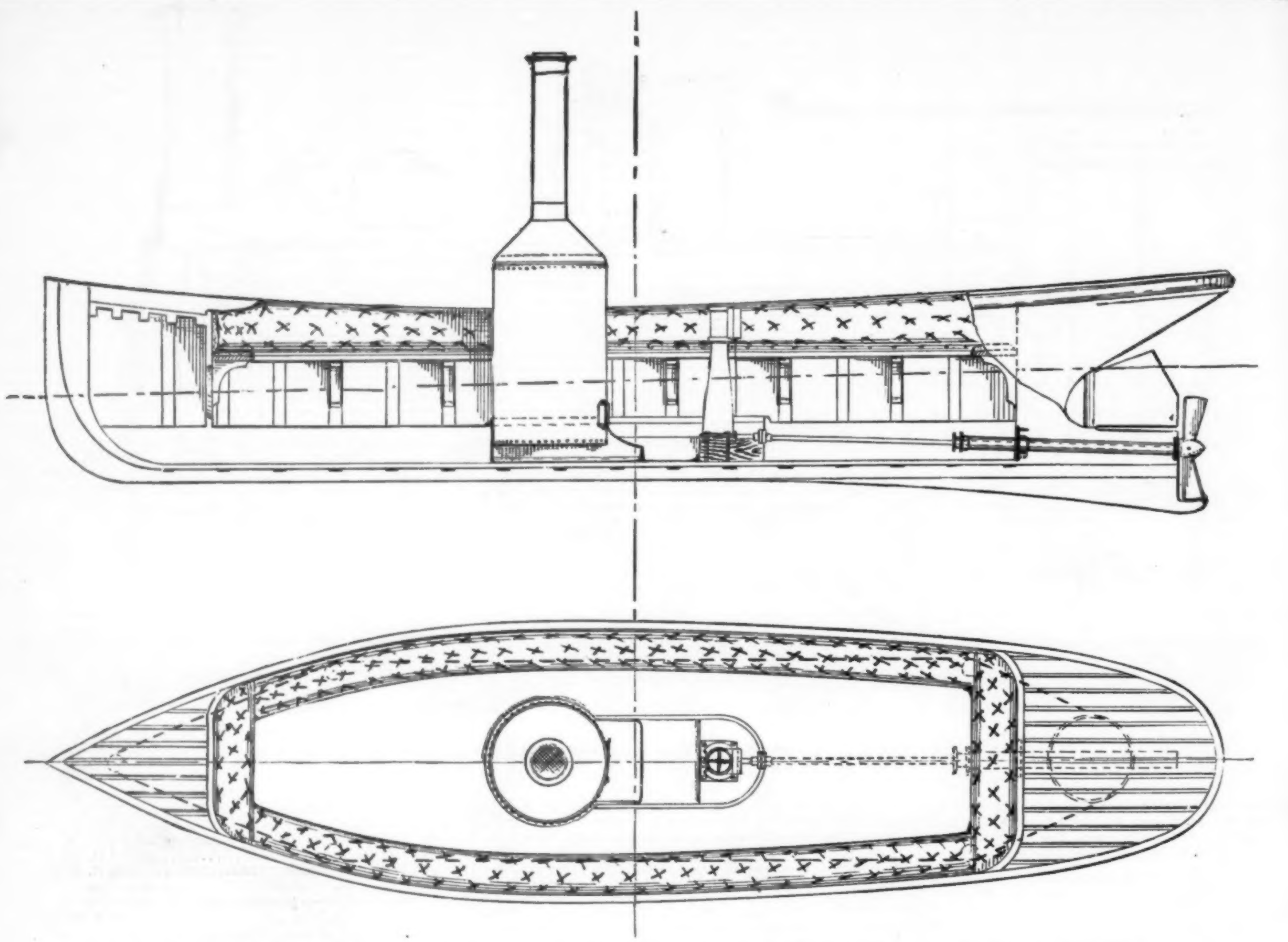


FIG. 1.—PLAN AND ELEVATION OF A SMALL STEAM YACHT. BY M. A. BECK.

SMALL STEAM YACHT.

Designed by M. A. BECK, Waterloo, Iowa.

THE principal dimensions are as follows:

BOAT.

Length over all	21 feet.
Beam	5 feet.
Depth of hold	26 inches.
Draught aft	30 feet.

PROPELLER.

Diam	24 inches.
Pitch	36 inches.
Blades	3

ENGINE.

Diameter of cylinder	3 1-2 inches.
Length " stroke	4 inches.
" " steam ports	2 3-4 inches.
Width " " "	1-4 inch.
" " exhaust "	9-16 inch.
Outside lap of valve	3-16 inch.
Inside " " "	1-64 inch.
Travel " " "	1 1-8 inch.
Lead " "	1-16 inch.
Diam. of steam pipe	1 inch.
" " exhaust "	1 1-4 inch
" " " " nozzle	1 inch.
" " crank shaft (steel)	1 3-16 inch.
Diam. of line shaft (steel)	1 inch.
" " crank " journal	1 3-16 inch.
Length of " " "	2 1-4 inch.
Diam. " " pin	1 inch.
Length " " "	3-4 inch.

BOILER.

Outside diameter	24 inches.
Height	40 inches.
Inside diameter of firebox	20 inches.
Height of firebox	16 inches.
Sheet, tubesheets and firebox (steel),	1-4 inch.
Tubes (weldless) steel	180
Diam. of tubes, outside	3-4 inch
Length " "	24 inches.
Pitch " "	1 1-4 inch.
Square feet of grate surface	2
" " " heating " in firebox	8
External tube heating surface, sq. ft.	69
Total square feet heating surface	77

BOILER ATTACHMENTS.

Injector:	
Maximum capacity	40 galls.
Minimun " per hour	20 galls.
Safety valve, type, Richardson;	
Diameter	1 1-2
Feed water heater.	

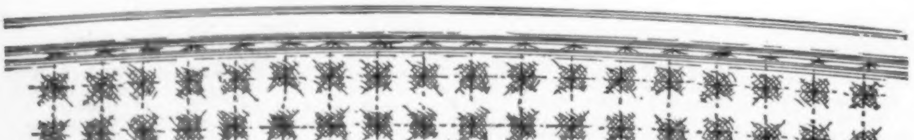


FIG. 2.—DETAILS OF SMALL STEAM YACHT.

With a good injector, this will be of little value, unless it is used as in this case, for the purpose of taking some mud and lime out of the water.

It may be from 2 1-2 to 3 inches in diameter; and it would be preferable to make that part of the exhaust pipe passing through it brass or copper. The space around the exhaust pipe may be loosely filled with scraps of sheet iron; after these scraps become thickly coated with mud and lime, they may be taken out and replaced with others.

The heater may be so constructed as to enable the runner to do this very quick and readily.

The remaining details, and general arrangement of machinery, will, we think, be readily understood by referring to the figures.

POSSIBILITIES IN GAS LIGHTING.

CERTAIN of the London gas companies—apparently acting on the advice which we gave them in a recent impression of this journal—are taking active steps to show that gas lighting is capable of great things. The introduction of the electric light has sufficed to prove that the world only puts up with gas because it can get nothing better; and that all the convenience of gas will not compensate for a manifest inferiority in illuminating power. Public authorities, manufacturers, and even shopkeepers, are quite prepared, it would seem, to incur all the trouble and expense of establishing an electric light plant, if only the result be satisfactory; and there is no room to doubt that electric lighting would have made much more progress than it has hitherto done had the results obtained for a considerable outlay been uniformly satisfactory. The time may not be far distant when all difficulties will be overcome, and we shall find in electricity a certain, steady, and powerful source of light, and it will then be adopted, even though a little more has to

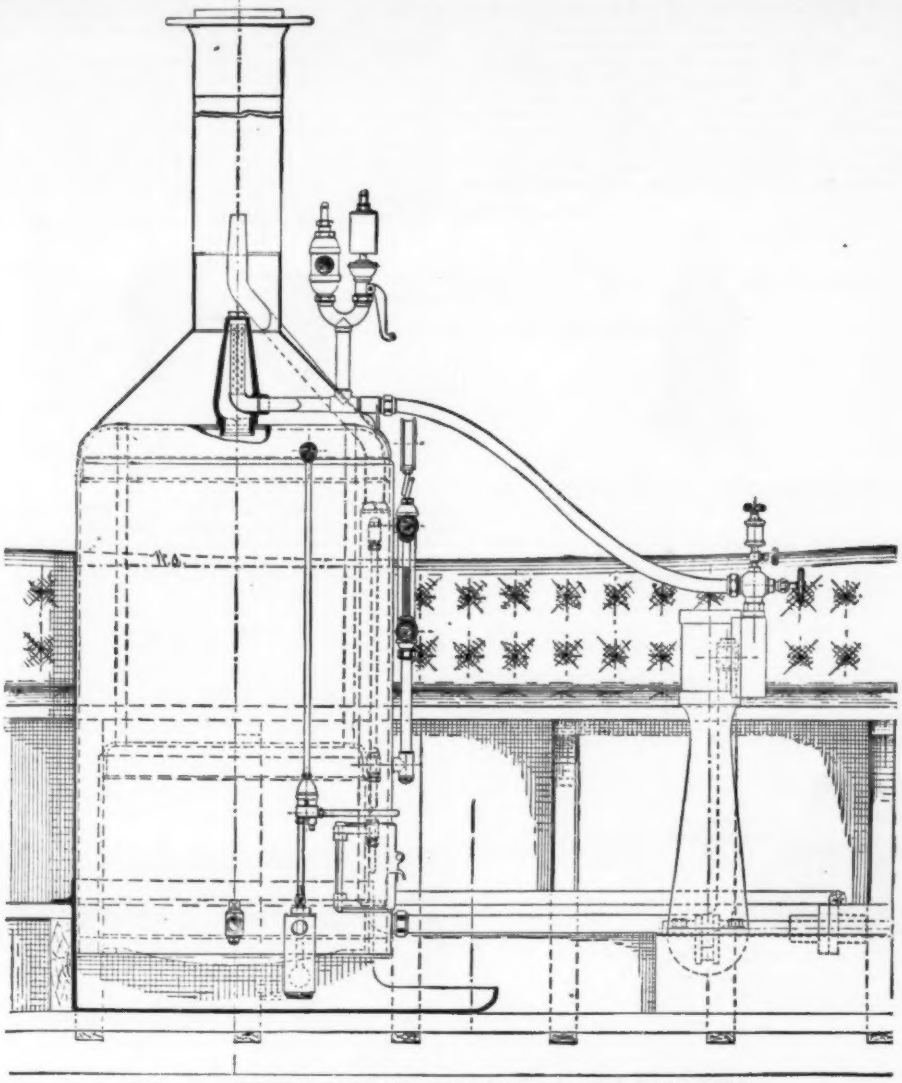


FIG. 3.—DETAILS OF SMALL STEAM YACHT.

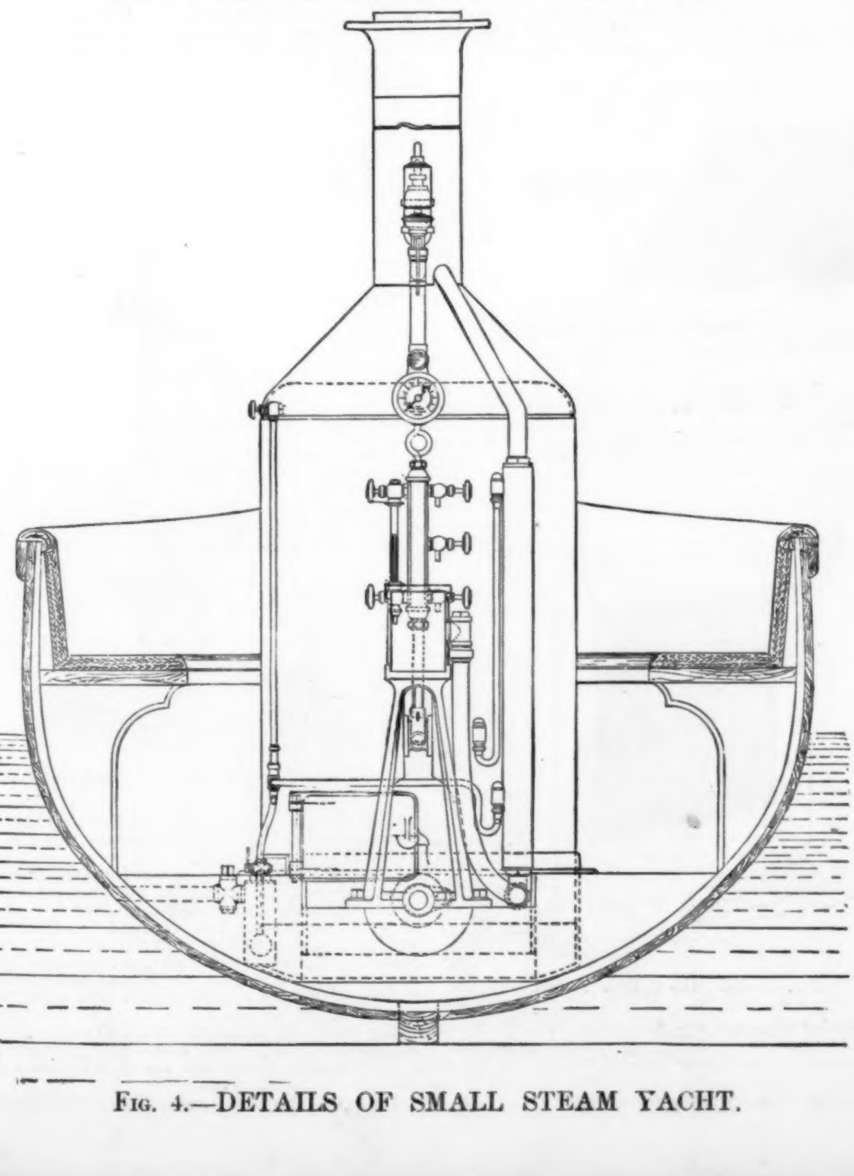


FIG. 4.—DETAILS OF SMALL STEAM YACHT.

be paid for it than for gas, unless it can be shown that gas will do as much, or nearly as much, for us as electricity. To urge that the electric light can never be adopted because it will cost too much, is futile. When London was lighted by oil lamps the cost of these lamps was, perhaps, not one-hundredth of that now paid for gas. But the additional cost of gas in no way retarded its adoption and the putting out of the oil lamps. Gas companies are in many respects wiser than the public, and, as we have said, they seem to be determined that before electricity shuts up the gas works there shall be a fight for supremacy. As a matter of fact, the sum paid for the impossible in gas lighting has not been nearly reached; and if the companies will but work properly in the right direction, electricity may find it a difficult task to oust its predecessor

The most recent improvement in street gas lighting has been effected by Mr. C. Woodall, who has re-lighted, if we may use the word, the piece of roadway between the foot of Waterloo Bridge and the South-Western Railway Terminus. The distance is about 500 yards. Very full descriptions of the arrangements have been published in all the London daily papers; and as the subject requires little technical knowledge on the part of those who have written about it, the descriptions in question are so full and accurate that we need say very little on the subject. Mr. Woodall is the engineer to the Phœnix Gas Company. The extra light afforded is paid for by the company. To give the public an opportunity of comparing the electric light with what can be effected with gas, twenty-two ordinary street lamps previously used have been replaced by forty-eight others of a new design, each giving the light of fifteen candles against twelve given before. Reflectors are added to throw down that light which is now wasted upwards by ordinary street lamps. At the York-road crossing are two refuges which have been fitted with lamps on the excellent triplex system, recently introduced by Mr. Sugg, one of which gives the light of 130 and the other the light of 200 candles; besides these, certain 50-candle argand burners have been added. We advise such of our readers as can manage it to go and judge for themselves of the effect produced. As to the expense, Mr. Woodall's figures are to the effect that the cost of gas for 4,200 hours per annum, at 3s. 4d. per 1,000 ft., will be £334 per annum. To this must be added interest on £120, the cost of the lamps; and cleaning, lighting, and repairing, 15s per lamp. The total amounts to £378 per annum. In other words, 500 yards of roadway can be thoroughly lighted for 1s.7d. per hour, as against 5$\frac{1}{4}$d., the cost under the old system. But by reducing the brilliancy of the illumination after midnight a saving can be effected which will bring the cost of the improved system to about 1s. 3d. per hour, or, say, three times that of the old plan. It remains to be seen if it is possible thoroughly to light 500 yards of roadway by electricity for 1s. 2d. per hour.

It will be seen that all the exertions hitherto made by gas companies and inventors, have naturally enough tended to the direct use of gas for lighting purposes. But there is reason to think that much more can be done with it by utilizing its heating power, to secure a first-class artificial light. A gas possessing great heating though bad lighting power, may be made for much less than a good illuminating gas; and the advantage which gas companies would gain, could such a gas be substituted for that in ordinary use, are very obvious. But it is unnecessary to go into this part of the question. Dealing with gas as we have it, we believe it may be shown that it is possible, by adopting very simple arrangements, to produce a light which will be only second to that of electricity. Much more has been done in this direction than is generally known by gentlemen whose names do not come very prominently before the public, while they are nevertheless working hard to obtain a first-class artificial light. We allude to the makers of magic lanterns. Most persons regard magic lanterns as toys, and so they were until within the last few years. Of late the magic lantern, under various more or less high sounding names, has come into fashion; and in its best forms it is a beautiful optical machine—we cannot call it an instrument—engaging in its construction and development some very able minds. Now one of the first essentials to a first-class lantern is a good light, and endless experiments have been carried out to obtain this. The lime light, in which an oxyhydrogen blowpipe is used to heat a little lime cylinder, is of course the best of all. But although oxygen gas can be had retail for 8d. per cubic foot, and four cubic feet will suffice for two hours, the cost and inconvenience of the requisite apparatus have stood in the way, and prevented the general use of the oxyhydrogen light. Next comes the light produced by using ordinary coal gas instead of hydrogen, the oxygen being supplied in copper bottles, each holding about 8 cubic feet. This light is used to a considerable extent but it has not proved quite satisfactory, and attempts have been made, and with success, to dispense with hydrogen and oxygen, and use coal gas and air. In Germany a lamp has been produced working in this way, which has since been improved by Mr. Woodbury, and is known as the pyro-hydrogen lamp. The principle on which it acts will be understood presently.

When any substance is burned with the proper quantity of air, it will theoretically develop a temperature normal to its constituents. Thus, carbon burned with 12 lb. of air per pound develops a temperature of 4640 deg. Fah. Hydrogen gas burned to water with oxygen gives a still higher temperature. In practice nothing like this can be obtained on a large scale, principally because the nitrogen of the air carries off much heat, and heat is also wasted by conduction and dissociation. Faraday, however, maintained that by using proper precautions the full temperature proper to the material consumed would be found to exist somewhere in its flame at one time, no matter how it might be dissipated subsequently; and he actually proved the truth of this statement by fusing a very fine platinum wire in the flame of a common candle. By substituting oxygen for air we get rid of all the loss caused by the presence of nitrogen; and we also produce a greater quantity of heat in a given time by promoting the rate of combustion, and so less heat is carried off in a given period by conduction. There is another way, however, in which we can neutralize the cooling effects of nitrogen and hurry combustion. This consists in burning a mixture of common air and coal gas, the air being previously heated to a high temperature, and supplied under pressure. The pyro-hydrogen lamp consists of a stand carrying a small disk of lime. On to the surface of this lime is forced a jet of mingled air and coal gas, previously heated to a high temperature by being passed through a coil submitted to the action of a powerful Bunsen burner at the top of the stand. The resulting light is stated by Mr Chadwick, in his excellent *Manual of the Magic Lantern*, to be, although not equal to the oxyhydrogen light, "superior for some optical purposes to any oil light with which he is acquainted;" and this is high testimony in its favor, for first-rate

"lanternists" are of all men the most exacting as regards artificial light. So much being premised, it is not difficult to see how a large hall might be lighted. Let us take, for example, the Leeds Town Hall. The wind is supplied to the great organ in the hall by seven water-pressure blowers. These are worked by the pressure in the town mains, and such a blower could be readily adapted to supply a sufficient quantity of air at a uniform pressure of, say, 3 lb. on the square inch. This air could be led in a suitable tube to a small furnace containing a coil of piping. In passing through this pipe the air might be raised to a temperature of 1,000 deg. to 1,200 degrees. Thence it would be led through pipes suitably cased in non-conductors, to a series of modified pyro-hydrogen lamps, placed in suitable positions. The cost of producing the resulting light should, it will be seen, be comparatively moderate. Of what the pyro-hydrogen lamp is capable it is impossible to say without further experiments than have yet been made; but it would appear that it can be adapted to the illumination of large public buildings, and possibly of streets, and even private houses. At any place within the metropolis it should be possible to obtain a moderate quantity of air under pressure, which is the first thing needed. There are various ways in which this air may be heated; and given hot air under pressure, and coal gas, it would seem that any required temperature may be obtained, and with heat enough comes the lime light —the true rival of the electric light. It may be worth while to add that experiments which have been going on for some months in Staffordshire go to show that large volumes of super-oxygenated air may be obtained for a very small cost, and if this be true then the work of the gas companies would be much facilitated.—*The Engineer*.

A FEW EXPERIMENTS WITH THE INDUCTION COIL.

By GEO. M. HOPKINS.

IN a former article* explicit directions were given for making an induction coil capable of yielding a 1½ in. spark. A few experiments will now be described which exhibit phenomena peculiar to the secondary current. The spark between the points of the wires that extend from opposite ends of the coil toward its center is of itself interesting and beautiful. It is in fact a miniature discharge of lightning of which we have control; but woe to us if we interpose a part of our body between these two points: we shall then experience in a small way the effect of a stroke of lightning.

When the points referred to are as wide apart as allowable within the limits of the length of the spark, the sparks leap rapidly from the one point to the other, giving a vivid light, and appearing altogether spiteful. A piece of paper or cardboard placed between the points is readily punctured, and the current finds its way through mica, the surface of which it will follow in various directions toward the hole through which it passes, at which point the spark is very bright.

A sheet of mica, about 4×6 inches, having upon one side a sheet of silver leaf 2×3 inches, may be used in some very pretty experiments. To apply the silver leaf to the surface of the mica it is only necessary to moisten the latter with the tongue and then lay on the leaf. When the sheet of mica, thus prepared, is placed, silvered side down, from ⅛ to ¼ inch from the rods, which are connected with the terminals of the secondary coil—as shown in Fig. 1—the spark leaps downward to the mica surface, and then travels in a tortuous route to the vicinity of the point of the other rod and leaps upward. These sparks follow each other in such rapid succession that the mica appears to have several sparks traveling across it at once; but such is not the case, only a single spark traverses the mica at a time, the impressions of the successive sparks being retained on the retina a sufficient length of time to cause the several sparks to appear as if simultaneous. By placing the mica plate in contact with the two rods, the spark may be made to travel further than it would otherwise. By separating the rods somewhat more

FIG. 4.—EXPERIMENTS WITH LEYDEN JAR.

than the length of the spark and placing the mica from ⅛ to ¼ inch below it, the current will be diffused over the mica surface in radial, purple streams. When one of the rods is allowed to project considerably over the silvered portion of the mica, and the other is allowed to project over it but very little, as shown in Fig. 2, the current escapes to the mica surface in purple streams and is diffused in all directions.

When a piece of glass is placed between the points, the spark will be deflected and pass around the edge of the glass; when a candle flame is placed near the path of the spark, the spark diverges toward the flame. The current will travel in all directions over a surface sprinkled with any finely divided metal, and will deflagrate some of the particles of the metal. By connecting a wire with one terminal of the secondary coil, and allowing its free end to dip in a glass of water, and placing a wire connected with the other terminal near the surface of the water, a spark will be obtained from the water. By incasing each of the terminal wires in a glass tube—leaving only the end exposed—and dipping the two wires thus incased in a glass of water, with their exposed ends near together, a vivid spark will be seen to pass from one wire to the other, showing that the spark is not extinguished by water.

A rapidly whirling disk, Fig. 3, as viewed by the discharges of the induction coil, appears stationary when the passage of the sparks and the passing of the radial bars of the disk by a fixed point occur simultaneously. This experiment exhibits the great velocity of the electric spark.

By increasing the speed of the disk, or reducing the rate of vibration of the interrupter, the disk appears to set up a slow retrograde motion; by decreasing the speed of the disk it appears to move slowly forward.

A Leyden jar being placed on an insulated table, K (Fig. 4), and having its inner and outer coatings connected with the poles of the coils by wires, *p*, *q*, adds greatly to the intensity of the spark between the pointed rods connected with the coil. The jar may be charged by insulating it and connecting one of the poles of the induction coil with the ball of the jar, and placing a wire connected with the other pole a little distance from the outer coating. The jar may be discharged with the ordinary discharging rod.

The fulminating pane, Fig. 5, consists of a glass plate

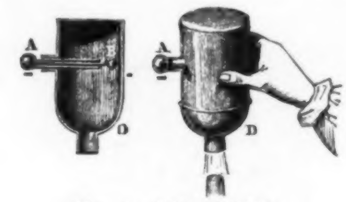


FIG. 6.—GAS PISTOL.

fixed in wooden supports, and having on opposite sides pieces of tin foil, leaving a free space all around the foil. The glass should be coated with shellac varnish; the varnish may be used in sticking the foil to the glass. The space between the tin foil and the edges of the glass should be about ¾ in. By connecting one of the tin foil surfaces with one of the secondary wires, and bringing the other wire near enough to allow the spark to pass to the foil, the plate soon becomes charged with contrary electricities, and discharges spontaneously over the edge of the glass, producing a loud report. By placing between the secondary wires in the path of the spark any highly inflammable substance, like gun cotton or common cotton sprinkled with lycopodium, it is readily exploded. Ether and the light hydrocarbons may be ignited in a similar way. A mixture of illuminating gas and air may be exploded by the spark by employing the gas pistol shown in Fig. 6. This consists of a small tin can, D, having a mouth fitted with a cork, and an insulated rod passing through one side and nearly touching the other. When this contrivance is filled with a mixture of gas and air, and the knob, A, is presented to one pole of the coil while the can is in communication with the other pole, an explosion follows.

Stateham's fuse, shown in Fig. 7, is employed in electric blasting. It is simply a gutta percha covered conductor, twisted together and interrupted; it is buried in gunpowder, which is ignited when the spark from the induction coil passes the break in the conductor.

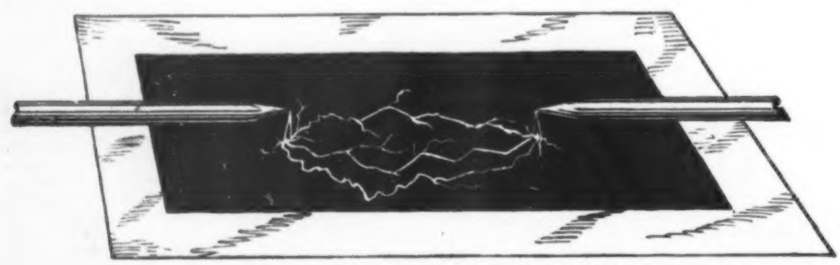


FIG. 1.—PATH OF ELECTRIC SPARK OVER MICA.

FIG. 7.—STATEHAM'S FUSE.

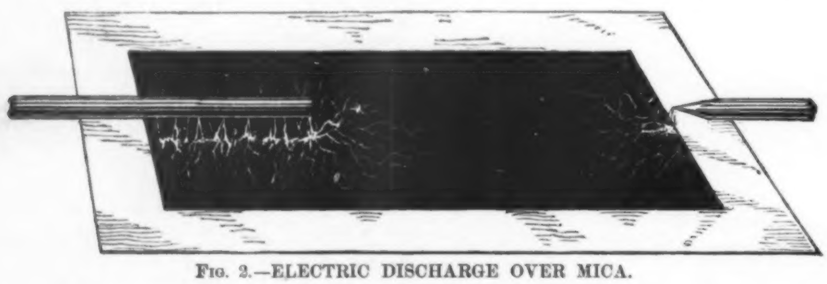


FIG. 2.—ELECTRIC DISCHARGE OVER MICA.

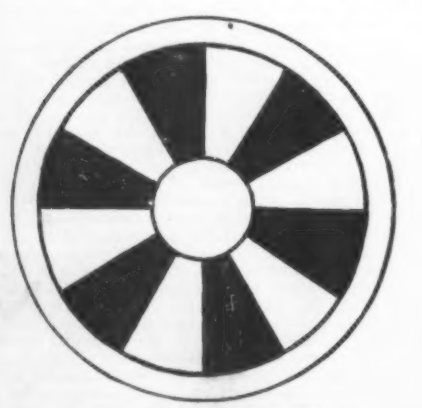


FIG. 3.—ROTATING DISK.

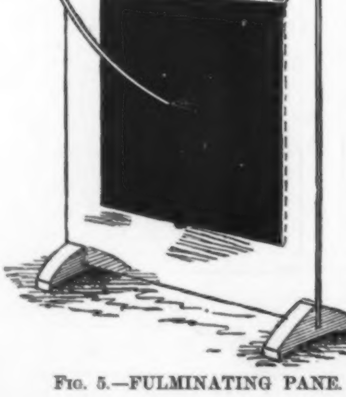


FIG. 5.—FULMINATING PANE.

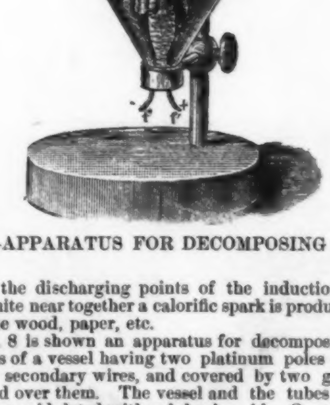


FIG. 8.—APPARATUS FOR DECOMPOSING WATER.

When the discharging points of the induction coil are placed quite near together a calorific spark is produced which will ignite wood, paper, etc.

In Fig. 8 is shown an apparatus for decomposing water; it consists of a vessel having two platinum poles connected with the secondary wires, and covered by two glass tubes suspended over them. The vessel and the tubes are filled with water acidulated with sulphuric acid. Oxygen is disengaged at the positive electrode, and hydrogen appears at the negative. These gases may be reunited by placing them in the gas pistol and exploding them by a spark, as before mentioned.

The experiments already described, although very interesting and instructive, do not compare in splendor with the class of experiments in which the electric discharge passes through a rarefied medium.

The remarkable beauty and brilliancy of the discharge is,

* SCIENTIFIC AMERICAN SUPPLEMENT, No. 160.

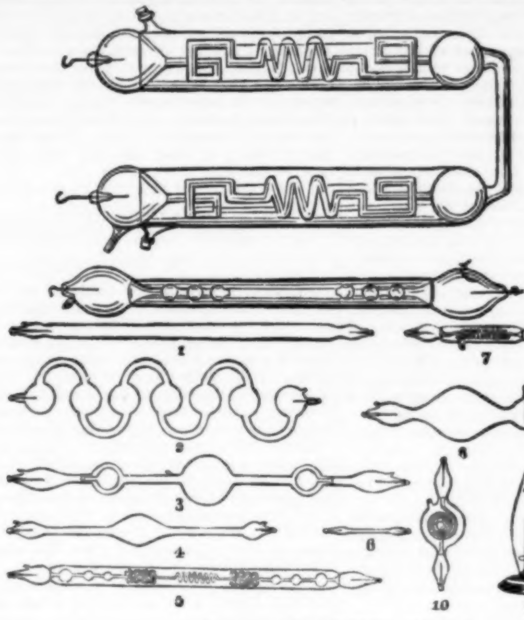


FIG. 9.—GEISSLER'S TUBES.

perhaps, best exhibited by the well known Geissler's tubes, several forms of which are shown in Fig. 9. In these the color of the discharge varies with the vapor contained by the tube, and it is also modified by the quality of the glass composing the tube.

In Fig. 10 the magnificent striæ which are produced in these tubes are represented. These striæ vary in shape, color, and luster, with the degree of vacuum, the dimensions of the tube, and the nature of the gas or vapor through which

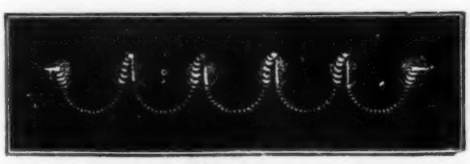


FIG. 10.—GEISSLER'S TUBES SHOWING STRATIFICATIONS.

the discharge takes place. In this figure the striæ given by hydrogen are represented.

In Fig. 11 is shown a bell glass adapted to the plate of an air pump, and provided with a packed sliding rod, which has at its lower end curved radial pointed arms, the ends of which point downward; at the bottom of the bell there is a similar series of arms pointing upward. When the air is rarefied in the bell, and the upper and lower series of points

FIG. 11.—LUMINOUS POINTS.

are connected with the secondary the wires, points become luminous.

The electric egg, shown in Fig. 14, is simply a large egg-shaped glass vessel, having a stop cock for attaching it to an air pump, and provided with a sliding rod at the top, and a metal rod at the bottom, which terminates in a ball and is in metallic connection with the base. The air being exhausted, and the upper and lower rods being connected with the poles of the induction coil, the light tuft between the two rods will assume an ovoidal form, and will become more nearly spherical as the air becomes more rare. When a piece of metal is presented to the side of the egg the current will be diverted from its path and flow toward the side of the egg, as seen in Fig. 12. When the glass globe contains a small portion of the vapor of alcohol, naphtha, or any light hydrocarbon, the character of the light is changed, being stratified, as shown in Fig. 13.

The experiment known as Gassiot's cascade (Fig. 15) is very beautiful. A goblet coated with tin foil, after the manner of a Leyden jar, is placed in a vacuum. The induction

FIG. 15.—GASSIOT'S CASCADE.

current is carried to its bottom by the wire passing through the cap of the air bell. The other electrode being in communication with the air pump plate on which the apparatus stands, when the current is established, "the goblet overflows like a fountain, with a gentle cascade of light, wavy and gauze-like, falling like an auroral vapor on the metallic base."

There are many other experiments which may be readily performed with an induction coil, and many of those described may be modified so as to present other interesting features.

FIGS. 12, 13, AND 14.—ELECTRIC EGG.

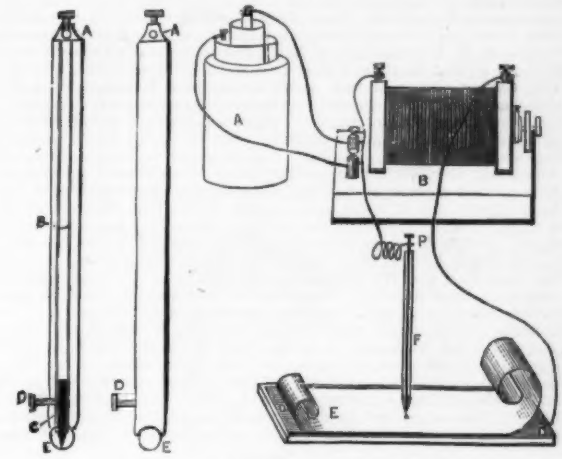
A SIMPLE ELECTRIC PEN.

WE give, as supplemental to the foregoing article on induction coil experiments, a description of a simple electric pen, which we extract from an article by Professor Wentworth Lascelles Scott in the *Electrician*.

The little contrivance which is shown in the accompanying engraving could be sold at a good profit for from 25s. to 30s. complete, or can be put together by any one possessing a very moderate amount of electro-mechanical skill at even less cost than the former sum, while the "pen" *per se* is as convenient and as light to hold as an ordinary pencil, and can be actuated by a comparatively very small single cell battery.

The accompanying rough sketch needs but little explanation, and shows fairly well the arrangement devised and actually used by me.

A is a Daniell's cell of medium size, which is all the battery power required; indeed, a very small bichromate or "Marié-Davy" couple may often be substituted here, where the pen is not required for very hard and continuous use. The battery is connected in the usual way to the primary ter-



A SIMPLE ELECTRIC PEN.

minals of a small induction coil, B, and for this purpose one of the little coils generally accompanying the cheap French sets of apparatus for "vacuum tube experiments," answers very well if certain simple improvements be applied thereto. As a rule these tiny "Ruhmkorffs" give a secondary spark of from one-eighth to three-sixteenths of an inch in length, but would give a much longer one, only that the vibrating armature is not sufficiently delicate, while the condenser is often only a delusion and a snare. The former should be more delicately adjusted, a really elastic bit of spring being added if necessary, and the latter should be taken out and replaced by a sound and practical condenser, containing 300 or 350 square inches of tin foil, carefully insulated with paraffin paper. When these alterations are completed, it will be found that the spark is increased in length to some five-sixteenths of an inch, or even more. The desk or writing slab consists of a plate of glass or vulcanite of suitable dimensions, upon which has been evenly laid a perfectly smooth, but rather smaller sheet of silver or tin foil, D, the whole being protected from damp by a coat of thin amber varnish; at one corner of the slab is fixed a binding screw, E, in contact with the metallic surface, and connected by a wire with one terminal of the secondary coil.

The writing stylus or "pen," F, consists of an ivory or vulcanite tube, pointed at its lower extremity, and provided at the other end with a small brass terminal; from the latter a stiff wire, furnished with an extremely fine platinum point (*p*), proceeds in the interior of the tube, and is capable of adjustment by a small set screw. In practice this platinum point should be (when the stylus is turned up) very slightly below the level of the aperture in the ivory. The "pen" being then connected to the free terminal of the secondary, and the little coil set so that the primary sparks appear almost continuous by reason of their very rapid succession, a sheet of paper laid upon the slab, C, will be quickly perforated in a series of minute holes if the point of the stylus be gently drawn over it. Any writing, plan, or outline drawing may be traced in this way upon the paper, although in a somewhat slower manner than with an ordinary pen. When removed from the slab the paper is found to be a kind of stencil plate, from which, by laying in succession upon a number of sheets of paper, and applying the ink roller or "dubber," many hundred *fac-simile* copies may easily and quickly be obtained.

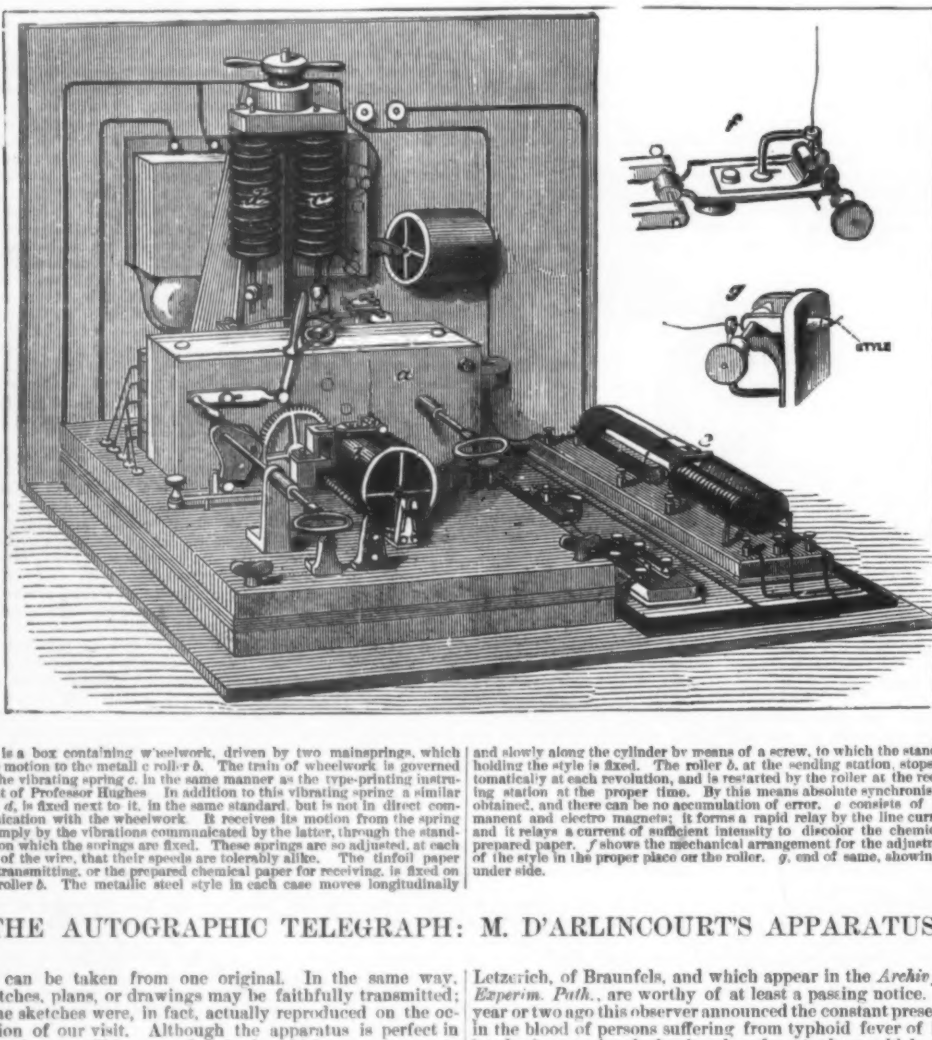
If an "electro-stencil" of a large architectural or other plan or of a map be wanted, a slightly modified stylus will facilitate the work. Fig. 2 shows such an instrument drawn to scale (half the original size), Fig. 3 being a section of the same.

A represents the terminal for the reception of wire from coil. B is a brass tube extending to within an inch of the "writing," or lower end of the stylus, where it receives a pointed platinum wire, C, which can be fixed at any required height by means of the set screw, D. A small ivory wheel, E, enables the stylus to travel easily and evenly over any long continuous lines, either with or without the aid of a ruler.

AUTOGRAPHIC TELEGRAPHY.

AUTOGRAPHIC telegraphy, or the process of transmitting messages in the actual handwriting of the sender, has occasionally, during the past thirty years, constituted the special study of scientific minds. So long since as 1850 Mr. F. C. Bakewell invented a copying telegraph by means of which autographic telegraphy was effected, and this was probably the first time it was effectually accomplished. In this instance the message was written by the sender with a gummy ink or varnish on metallic paper or tin-foil, and this writing was by the aid of mechanism used to actuate electric currents in such a way as to produce a record at the distant station by the chemical decomposition of a solution with which the receiving paper was damped. Both the written message and the paper were fixed around cylinders of similar form and dimensions, one being placed in the transmitting and the other in the recording instrument, and the cylinders were caused to revolve with corresponding velocities. Each time the gummy, and, consequently, raised lines of the writing were crossed by a pointer under which the metallic paper was traversed in the transmitter, a mark corresponding in position was made on the prepared paper at the receiving end. It therefore followed that the sum of all the marks reproduced the writing itself. Mr. Bakewell successfully reproduced the writing in white on a blue ground, but the process failed to become one of public utility owing to the extreme slowness with which the apparatus worked and the difficulty that was experienced in maintaining uniform the synchronous motion in the instruments. In 1856 the Abbé Caselli, in Italy, endeavored to solve the problem of autographic telegraphy in a similar manner. His apparatus was exhibited in England, and it was used practically between

Paris and Marseilles, and Paris and Lyons. Plans, drawings, and autograph sketches were faithfully reproduced at distant places, but it was found that the apparatus had not only the defects of Bakewell's, but it was very costly and complicated. Two other subsequent workers in this direction were M. Meyer and M. Lenoir, who tried to accomplish the same results with ordinary ink. They, however, pursued their investigations quite independently of and unknown to each other. We have recently been afforded the opportunity of examining the latest example of this class of apparatus at the General Post Office, London, where it has been submitted to the authorities for trial. This is the invention of M. D'Arlincourt, of Paris, and its general principles are similar to those which govern Bakewell's system. The distinguishing feature in D'Arlincourt's apparatus, however, is the introduction of an extremely ingenious synchronous movement, by means of which the speed of travel of the cylinders is rendered uniform, both in the transmitting and the recording machine. The message to be sent, which may be either in the ordinary hand or shorthand, is written with a thick gummy ink upon a strip of metallic-faced paper about 12 inches long and 2½ inches deep, which is wrapped around the cylinder of the transmitting instrument. A strip of white paper chemically prepared, and of similar dimensions, is placed on the cylinder of the recording apparatus, and the instruments are placed in electrical connection and started. The raised writing, actuating the electric current, causes a reproduction of the original message in facsimile on the paper in the recording instrument, which may be hundreds of miles away from the other. Upon the occasion of our visit the two instruments, although in the same room, were practically placed 200 miles apart. The writing can be reproduced in either blue, brown, red, or black, according to the chemical preparation of the paper, but always on a white ground, and a number of cop-



a is a box containing wheelwork, driven by two mainsprings, which give motion to the metallic roller *b*. The train of wheelwork is governed by the vibrating spring *c*, in the same manner as the type-printing instrument of Professor Hughes. In addition to this vibrating spring a similar one, *d*, is fixed next to it, in the same standard, but is not in direct communication with the wheelwork. It receives its motion from the spring *c*, simply by the vibrations communicated by the latter, through the standard on which the springs are fixed. These springs are so adjusted, at each end of the wire, that their speeds are tolerably alike. The tinfoil paper for transmitting, or the prepared chemical paper for receiving, is fixed on the roller *b*. The metallic steel style in each case moves longitudinally and slowly along the cylinder by means of a screw, to which the standard holding the style is fixed. The roller *b*, at the sending station, stops automatically at each revolution, and is restarted by the roller at the receiving station at the proper time. By this means absolute synchronism is obtained, and there can be no accumulation of error. *e* consists of permanent and electro magnets; it forms a rapid relay by the line current, and it relays a current of sufficient intensity to discolor the chemically prepared paper. *f* shows the mechanical arrangement for the adjustment of the style in the proper place on the roller. *g*, end of same, showing its under side.

THE AUTOGRAPHIC TELEGRAPH: M. D'ARLINCOURT'S APPARATUS.

ies can be taken from one original. In the same way, sketches, plans, or drawings may be faithfully transmitted; some sketches were, in fact, actually reproduced on the occasion of our visit. Although the apparatus is perfect in its action, it still has one drawback, which was common to its predecessors—that of slowness of reproduction. The time occupied in revolving the cylinder a sufficient number of times to allow the pointer to traverse the whole surface of the paper is seven minutes, and this rate of speed is far below that required and attained in practice for commercial purposes. The Post Office authorities, to whom we are indebted for our inspection, do not, therefore, see their way to utilize M. D'Arlincourt's ingenious invention at present. It is, however, being worked in France in fortresses and for similar military purposes, for which, in some special cases, it is exceedingly well adapted.—*Illustrated London News.*

BEETROOT PHOTOGRAPHS.

A PAPER was read lately before the French Photographic Society, by M. Pellet, on some experiments that he has made as to the action of the juice of beetroot on perchloride of iron under the influence of light. By pressure, a liquid of 1030° of the densimeter was obtained from the leaves of beets. A standard solution of iron perchloride containing ten per cent. of the salt at 45° B. was then prepared, and also a second solution containing ten grammes of iron salt in the same proportion, to which fifty c.c. of the juice of beet had been added; the latter solution was then made up to 100 c.c., when a slight precipitate was formed. After filtering, two portions of a piece of paper were brushed over with each of the two solutions respectively, and put to dry in the dark. A drawing executed on tracing-paper was now placed in an ordinary printing frame with its right side touching the glass, and underneath a piece of the paper sensitized with the two solutions as above described, and the whole was then exposed to the light. After some trials, it was established that to obtain a complete reduction of the salt of iron in the standard solution, it required an exposure of ten minutes to direct sunlight, while with the solution containing the juice of the leaves of beet one of from two to three minutes only was necessary. In order to determine the exact time when the complete reduction is effected, M. Pellet uses a saturated solution of yellow prussiate of potash. The paper exposed for a sufficient length of time under a tracing gives a blue color in all the parts corresponding to the lines—that is to say, where the salts of iron have remained in the state of per-salt—while no color is produced in the insolated parts where the iron salt has been reduced or converted into the condition of protoxide, on which the prussiate produces no action. In this way prints are obtained in blue lines on a white ground. Still further experiment showed that crystallic sugar, when added to a solution of ferric perchloride, does not diminish the time of exposure, and consequently has no effect in reducing the salts of iron. The results deduced from these experiments are:—1. That the juice of the leaves of beet have the property of facilitating the reduction of the iron salts under the influence of light. 2. That this reduction may be effected in the dry state with solutions, therefore, that have probably no vitality. 3. That the reduction is due to the oxidation of one or more organic substances contained in the leaves—such as sugar, tannin, nitrogenous compounds, and vegetable acids.

THE PATHOLOGY OF TYPHOID.

THE announcement of the discovery of the fungus of typhoid fever will be received with considerable hesitation by most of our readers, with the result of certain not very remote investigations in their minds. Nevertheless, a series of researches which have recently been published by Dr. Letzerich, of Braunfels, and which appear in the *Archiv für Experim. Path.*, are worthy of at least a passing notice. A year or two ago this observer announced the constant presence in the blood of persons suffering from typhoid fever of isolated micrococci and of spherules of protoplasm which, under cultivation, speedily developed to micrococci, minute, round, or ovoid refracting corpuscles, moving in the blood-plasma, and possessing a great power of resisting the action of acids and alkalies. By the simple growth of these isolated bodies there arise, it is said, spherules of protoplasm in which appear myriads of first rods and then granules. In the height of the disease the blood from the arm contains, moreover, colonies of micrococci connected together irregularly, but these are believed to come, not from the blood, but from the lymph spaces. Both the forms which are seen in the blood, the granules and spherules, wander through the walls of the vessels into the tissues, and in the nerve tissues they are said to cause signs of irritation.

Many experiments were made upon rabbits by the injection of the organic bodies from the typhoid stools. By allowing the stools to stand in glass cylinders, and repeatedly washing, a layer a few millimeters thick was at last obtained, containing a large proportion of micrococci. The injection of this caused in rabbits a typhoid-like illness lasting a fortnight, ending sometimes in death, and presenting, after death, enlargement and induration of Peyer's glands, and great swelling of the mesenteric glands. The appearances were the same whether the poison was given by the mouth or by hypodermic injection. In the latter, there was first an infection of the neighboring lymphatic glands, due to a growth of organisms and increase of cells. By the extension along the lymphatics these micrococci become generalized, and post mortem they may be recognized everywhere, but especially in the intestinal canal, where the affection is chiefly localized. When the poison is given by the mouth, the intestinal canal appears first to be affected, and from that the generalization occurs. In no case, however, was ulceration of the intestinal glands found, and this must be admitted to constitute a grave discrepancy between the affection thus produced and typhoid fever. The localization of the affection was most intense, however, as in typhoid, in the lower part of the ileum. From these researches Letzerich concludes that typhoid must be regarded as a pure schistomycosis. It must be confessed, however, that, clear and apparently satisfactory as these statements are, and probable as such conclusions are from the knowledge we possess of the pathology of other diseases, they still "need confirmation."—*Lancet.*

NOTES ON PEROXIDE OF HYDROGEN AS A DISINFECTANT AND DEODORANT.

By JOHN DAY, M.D.*

PEROXIDE of hydrogen contains a larger proportion of oxygen than any other known substance, one-half of which is held in very loose combination, and readily given up in the presence of decomposing organic matter, and this constitutes it a good disinfectant and deodorant for general purposes. It possesses one property, however, which renders it pre-eminently adapted for the disinfection and deodorization of wounds and ulcerated surfaces, viz.: that when brought into contact with either blood or pus it is quickly resolved into water and oxygen—a gas which, in its nascent state, is possessed of great chemical activity. It is worthy of remark that this decomposition takes place far more energetically in the presence of pus than of blood; indeed, I am disposed to think that, when peroxide of hydrogen is added to a mixture of blood and pus, the pus-cells are almost entirely destroyed before the coloring matter of the blood or its corpuscles are affected.

It is certainly curious, to say the least of it, that from the earliest days up to the present time nearly all those substances which have gained repute as remedies in the treatment of wounds and ulcerated surfaces should have been found to possess the property of absorbing atmospheric oxygen and converting it into peroxide of hydrogen. I will just name a few of the best-known remedies of this class, both ancient and modern, in which I have clearly traced the presence of spontaneously generated peroxide of hydrogen. They are as follow: Oil and wine, Fryar's balsam, myrrh, oil of turpentine, resin, common strapping, fats and fixed oils, and carbolic oil. I may observe that there appears to be some antagonism in the chemical properties of peroxide of hydrogen and carbolic acid; for instance, when peroxide of hydrogen is added to a solution of iodide of potassium the iodine it liberates is quickly bleached on the addition of a little carbolic acid; and when guaiacum resin has been oxidized and turned blue by the joint action of peroxide of hydrogen and blood, the addition of carbolic acid will restore it to its normal color.

With the knowledge before me that so many of those substances which experience has taught men in all ages to believe in as remedies for wounds and ulcerated surfaces are capable of generating peroxide of hydrogen, I some time ago commenced a series of experiments for the purpose of learning, if possible, some mode of communicating this property to materials in common use as surgical dressings, and I think I have met with a fair share of success; but I have little doubt that there are members of this society who could readily improve upon my method. On the table are specimens of flannel and calico bandages, lint, cotton-wool, tow, and sponge, all of which have been submitted to a chemical process by which they have acquired the property of generating peroxide of hydrogen, which, unless brought into contact with blood, pus, or any other substance for which its oxygen has an affinity, will remain stored up in their textures for a very long time—certainly for many months.

The process, which is exceedingly simple and inexpensive, consists in well soaking the material to be rendered disinfectant in a fluid, the constituents of which are: either oil of turpentine or oil of eucalyptus, and benzine, with the addition of oil of lavender, or any other essential oil with an agreeable odor. As nearly all the liquid hydrocarbons are capable of generating peroxide of hydrogen, the ingredients and proportions may be varied to almost any extent. Oil of eucalyptus forms a very pleasant disinfectant and deodorant, and may be substituted for the oil of turpentine, but as it does not generate the peroxide quite so freely as it is generated by oil of turpentine, it should be used in rather large proportions. My favorite formula is: Benzine, 14 parts; oil of turpentine (the older the better), 2 parts; oil of lavender, 1 part. The drying process should be conducted slowly, either in a well-ventilated and well-lighted room or in the open air.

The presence of peroxide of hydrogen in any of the articles now before you can readily be detected by the addition of a little iodide of potassium in solution, when the iodine will be quickly liberated, giving rise to a dark brown stain, or a little watery solution of the coloring matter of blood may be first applied, and then a few drops of an alcoholic solution of guaiacum resin, when a bright blue reaction will be the immediate result.

THE ORGAN OF HEARING IN HEALTH AND IN DISEASE.—AN ESSAY ON CURABLE AND PREVENTABLE DEAFNESS.

By W. S. BOWEN, M.D., Providence, R. I.

A DISTINGUISHED writer on scientific subjects in this country has observed that "our hearing, like our sight, is used with so little consciousness, that we do not realize its value until it is either impaired or lost." This, certainly, holds true, and it will, doubtless, be of interest as well as profit to the great majority of the readers of the SCIENTIFIC AMERICAN to know that the old maxim, "An ounce of prevention is equal to a pound of cure," applies with as great, or indeed greater, force to the *prevention* of the establishment of ear affections as to those of other organs or members of the human body.

The science of otology is one of very recent existence. It is but within a comparatively few years that this department of the healing art has been rescued from the hands of the charlatan, and from a very doubtful and uncertain specialty there has been created an almost exact and certain science. For this great result, so overflowing with benefit to humanity, we have to remember, with a degree of gratitude future generations will not fail to realize and appreciate, the names of Toynbee, Politzer, and Gruber, the fathers of the science of otology as it exists to-day. Their investigations have done as much for the comfort of man—for what greater comfort is there than perfect hearing?—as Jenner did for the

* Read before the Pharmaceutical Society of Victoria, November 13th, 1878.

safety of the race when he utilized the discovery of vaccination.

Persons of cultivation, and those belonging to the professions and in the daily occupations of life, realize the sense of hearing as one of the utmost importance; and this is also extended to those whose comfort and recourse is in society, for a moderate or high degree of impairment of hearing debars all such from other than tedious, limited, and, indeed, painful conversation with others, and thus life becomes a burden.

It is the purpose of the writer, first to briefly describe the organ of sound in health, and then refer to those diseases and conditions attended by loss of hearing, that are especially the result of neglect or ignorance, and which are readily amenable to successful treatment if attended to. Of the large number of cases that present themselves to the aurist for treatment, and are by him assigned to the limbo of incurables, a great proportion are incurable chiefly from neglect in the early or commencing stage of the disease, and the honest surgeon can only convey the unwelcome tidings that nothing can be done to re-establish the lost function which, in the past, might have been either fully or partially restored.

The ear is divided into two portions: the conducting and the fundamental.

The first transmits sounds; the latter perceives them, and the subject realizes that he "hears."

The ordinary scientific divisions of the ear are three: the external, middle, and internal ear; this being based on the position of the parts, and is also useful in connection with the proper understanding of function and of the diseases belonging to each.

The *external ear* consists of the auricle, the name given to the cartilaginous and fleshy portion attached to the side, popularly known as "the ear," and the external auditory canal, the tube, the orifice of which is seen at the bottom of the auricle, leading inward through the bony wall of the skull an inch and a quarter in the adult. The farther end is closed by a delicate fibrous membrane, stretched across the canal at almost a right angle, the membrana tympani or drumhead. The canal is of an average width of a quarter of an inch, is slightly curved in its course, and is lined with a continuation of the integument of the auricle. It contains a growth of short stiff hairs, which are usually covered with a moderate amount of a sticky brown substance known as cerumen or wax; this varies in quantity, and when in excess causes deafness and other serious disturbance.

The *middle ear* consists of the tympanic cavity, or drum, a small space wholly contained in the temporal or side bone of the skull; the mastoid cells; the Eustachian tube; the ossicles, and the drumhead previously mentioned. The tympanic cavity is about the size of a large grain of coffee, and is lined with a delicate membrane, continuous with that of the throat and nostrils, with which it is connected by the Eustachian tube. This is a small canal about 36 mm. in length, commencing in the pharynx a little above the posterior opening of the nose, and running backward, upward, and outward to the tympanic cavity, which it enters anteriorly. The great bearing of this aerial connection between the throat and the cavity of the middle ear will be apparent when we mention that a large proportion of all deafness arises from the extension upward from the throat along this tube of Eustachius of morbid processes. The mastoid cells are open spaces in the mastoid portion of the skull, the prominence of which is felt by a finger placed directly behind the auricle on a level with the orifice of the external canal. The mastoid cells communicate with the posterior portion of the tympanic cavity through one or more small openings. On the inner side of the tympanic cavity are two little openings in the bony wall, named from their shape the round and the oval foramina, both covered with delicate membrane and connected with the drumhead on the outer side of the cavity covering the opening of the external canal by the ossicles. These are three little bones, and form the connecting link between the external and internal ear, and are suspended in the upper part of the tympanic cavity. They are called, from their supposed resemblance to these familiar objects, the malleus or hammer, the incus or anvil, and the stapes or stirrup. This last is the smallest bone in the human body, and is in shape almost an exact copy of an old-fashioned iron stirrup. The hammer is about 8 mm. long, and its thickest part, the head, is 2¼ mm. The greatest length of the anvil is 7 mm., and its thickness about 2¼ mm. The stirrup is 4 mm. high, and 2 mm. broad. The long process or handle of the hammer is firmly attached to the drumhead. The anvil is joined to the head of the hammer on the one side and to the top of the arch of the stirrup on the other, the base of the stirrup being adherent to the covering of the foramen ovale previously mentioned. This chain of bones forms a movable connection between the external and internal drumheads; the membrane covering the oval opening being sometimes called by the latter name. The tympanic cavity contains two little muscles which control the motions of the hammer and membrana tympani to a certain extent. They will be again referred to in connection with the movements of the membrana tympani.

Two important nerves pass through the tympanic cavity along its floor, and are distributed to the face and the tongue. Injury to these nerves received by them in the passage through the tympanic cavity is not of infrequent occurrence, and this will be referred to again. The upper part of the tympanic cavity is separated from the brain above by a thin brittle plate of bone, in some cases no thicker than a wafer.

The two portions of the ear already described constitute the *conducting* apparatus of sound; the receptive, or fundamental portion, is the internal ear, very complex and difficult of understanding to the general reader without the aid of elaborate plates and drawings. The internal ear is situated immediately behind the round and oval foramina, and is contained in certain very irregular and complex openings in the hardest portion of the temporal bone. It consists of the vestibule, the three semicircular canals, and the cochlea. So complex are these parts they are usually, when collectively referred to, called the labyrinth by anatomists, and their accurate dissection is a work of great delicacy and experience. By carefully opening the ear of a turkey's head a very good idea of the internal ear can be obtained by any one possessing patience and a moderate amount of mechanical skill. The vestibule is a very small cavity situate behind the membrane covering the foramen ovale in which the foot of the stapes is attached. It is about 3 1-2—3-4 mm. in diameter each way, and its upper and inner side are the openings of the semicircular canals. The canals are shaped as their name implies, and are connected together at the end of the ellipses. The length of each canal following their curves varies; it is about 20 mm. for the longest, and 16 mm. for the shortest. They are openings in the bone, are lined with membrane, and contain what are called the saccules, and also two fluids, the endolymph and the perilymph. The latter is identical with a fluid found in the membranes of the brain, and is derived from that source through a small opening communicating with the cavity of the skull. In the endolymph are not infrequently found little concretions of crystals of carbonate of lime called otoliths; their purpose, however, is not positively demonstrated by physiologists. The cochlea is a canal in the bone, connected with the vestibule, and twisted 2 1-2 times around a bony pillar. It is so like the appearance of a small snail shell as to give rise to the name of the cochlea. Its height is about 4 1-2 mm., and this is also the diameter of its base. The spiral canal of the cochlea is the most interesting of all the parts of the ear. Within it are contained the organ or arches of Corti, named from the anatomist who first accurately described them. To avoid any elaborate explanation of them it may be simply said that they are about 3,000 in number, and so delicate as to be examined with accuracy by aid of the microscope only. They are the ultimate terminus of the branch of the auditory nerve distributed to the cochlea. The auditory nerve, the great nerve of hearing, arises at the base of the brain, and passing outward through a small opening of the bone enters the labyrinth of the internal ear and divides into two branches, one going to the semicircular canals and the other to the cochlea. The fibers of Corti's organ are supposed to be the ultimate origin of the sense of hearing. Although the subject has always been one for discussion, the results of the researches of Prof. Helmholtz of Heidelberg are generally accepted. He considers that each one of the 3,000 fibers of Corti is constituted or tuned so as to perceive a note or portion of a note of the musical scale, "just as in the pianoforte each wire is tuned to a note different to that of its fellows." Says Helmholtz: "If we leave out of consideration two hundred of the arches of Corti, too high to be used in the ordinary musical scale, we still have 2,800 for the seven octaves of the ordinary musical instruments, *i. e.*, 400 for each octave, and 33 1-3 for each semi-tone—quite enough to explain the ability of perceiving fractional parts of a semi-tone whenever such ability exists."

Having thus considered the different components of the organs of hearing, we will now briefly enter upon the physiology of audition, omitting anything purely technical or uncertain.

Sound has best been described by Prof. Tyndall. It is a sensation received by the auditory apparatus, and communicated to the brain; its various inflections and its variations in intensity, pitch, and distinctness are regulated by functional acts peculiar to certain portions of the ear.

The description of the familiar experiment of Tyndall, illustrating the development of sound, will perhaps afford a better understanding than any other. A small collodion balloon is filled with a mixture of hydrogen and oxygen gas and then brought in contact with a flame. All present are conscious of a sensation recognized as sound. The explosion of the inflammable gases produces this. When the flames touched the mixed gases they combined chemically, and this union was accompanied by the development of intense heat. The air at this hot focus expanded suddenly, forcing the surrounding air away violently on all sides. This motion of the air close to the balloon was rapidly imparted to that a little further off, the air first set in motion coming at the same time to rest. The air at a little distance passed its motion on to the air at a greater distance and came also in its turn to rest. Thus each shell of air, if I may use the term, surrounding the balloon, took up the motion of the shell preceding and transmitting it to the next succeeding shell, the motion being thus propagated as a *pulse* or *wave* through the air.

The row of bricks placed on end and set in motion by tipping over the first one, a familiar juvenile amusement, affords another simple illustration of the communicated movement of ether particles. Each brick, after expending its force on the next succeeding one, remains in its place, and the impulse received from the first brick only ceases when there are no more to be overthrown. This development of sound applies likewise to its development under all conditions. The explosion of a cannon, the ringing of bells, the song of birds, the joint murmur of insects, and the human voice, all alike are due to one and the same cause—the setting in motion of air particles, if they may be so called, and this motion is continued until it is lost in space. The limit of this motion and the distance to which it is carried is governed, of course, by the intensity of the force applied to the air at the point of its development.

The ear is especially and in the most marvelously exact manner adapted to receiving these sound waves and communicating them to the brain of the hearer. To follow the transmission of the waves of sound to the brain, we have to consider nearly all the components of the ear previously described. The auricle, the outline of which so closely resembles that of certain marine shells, is placed on the side of the head in a convenient position to catch and collect the sound waves as they impinge against its surface. In the lower animals the auricle is not infrequently much larger proportionately, and in many cases admits of much freer motion in different directions than in man. The auricle of the horse, cow, dog, fox, wolf, and cat has motions peculiar to itself, and the same may be said of nearly all animals. The human auricle, with rudimentary muscles only, has little or no voluntary motion on the side of the head. It is fixed in one position, its concavity inclining forwards and outwards, and seems best arranged to catch sounds coming in those directions. The waves are collected by the tunnel-like expansion, and a portion of them are carried into the external canal to the drumhead. This membrane, stretched across the bottom of the canal, is highly elastic, and the impingement of the sonorous waves causes sufficient motion to communicate to the chain of ossicles, the hammer, the anvil, and the stirrup, a motion similar in degree to that of the drumhead, with which the hammer is connected. The motion is continued to the foramen ovale by the stirrup, and is imparted to the fluid with which the vestibule is filled. The cochlea, with its wonderful arrangement of cells connected with the expansion of the auditory nerve, receives the sonorous waves, and their pitch, intensity, and degree of tone are isolated and received by those of Corti's fibers adapted for that purpose. Thus isolated and defined sound is communicated by the auditory nerve to the brain, and what we know as "hearing" is realized. The passage of the sound waves through the structures of the ear is an involuntary act, and is unperceived by the hearer. It is only after they are received through the auditory nerve by the brain that function of hearing is apparent. What this realization is, what the reason and causes are for this wonderful power of the mysterious organ we call the brain, science at present does not reveal. Reason and observation are at fault, and God alone can solve the problem. Sound waves can be communicated to the labyrinth in a modified degree independently of the legitimate conducting apparatus of the ear in the course just described. Thus, a tuning-fork, set in vibration and the handle placed on the top of the head, the external canals being closed by a finger pressed on each, may be heard quite plainly. In the absence of the drumhead sounds can be heard in a modified degree; also, sounds in the mouth are carried along the Eustachian tube and appreciated by the internal ear and auditory nerve. The functions of the semicircular canals of the internal ear are subordinate to those of the cochlea, and are accessory only to the act of definition of sound. This subject is still one for discussion, their most probable action being the coördination of the motion of the sonorous waves by means of reflex action. The Eustachian tube serves mainly to permit a passage of atmospheric air to the tympanic cavity, a most important matter to be considered in describing diseases of that portion of the ear.

WAX IN THE EARS.

ON THE CEREBRAL SYMPTOMS PRODUCED BY IMPACTED CERUMEN.

By WILLIAM A. HAMMOND, M.D., Professor of Diseases of the Mind and Nervous System in the University of the City of New York. (Read before the New York Neurological Society, November, 1878.)

THERE is nothing new in the fact that impacted cerumen in one or both ears is capable of giving rise to notable disturbances of cerebral and nervous action, but the circumstance does not seem to have attracted the attention it deserves, except perhaps so far only as the sense of hearing is concerned. Kramer* does not even mention the existence of any brain symptoms in connection with the disorder in question, though specially detailing those exhibited as the result of noises in the ear.

Toynbee,† however, is more explicit. He says:

"The symptoms of a collection of cerumen in the meatus vary according to the nature and position of the mass. Sometimes the whole of the meatus is distended by cerumen, the inner end of which lies in contact with the outer surface of the membrana tympani of which it forms a cast. In these cases there is often giddiness, from the pressure on the chain of ossicles. The symptoms of pressure on the brain are familiar to most surgeons, but it is not generally known that pressure on the contents of the labyrinth produces somewhat analogous symptoms. A mass of cerumen may force inwards the membrana tympani and the chain of bones until the base of the stapes is pressed against the contents of the vestibule. In some cases of this nature constant attacks of giddiness occur; in others there is a confusion of ideas and an inability to walk straight, and in a third class there is a feeling of weight and pressure on the head. These symptoms are often combated by the use of counter-irritants and depletion; but the only proper remedy is the removal of the accumulation."

The author then cites several cases in which cerumen had accumulated in one or both ears, in only two of which, however, were there any cerebral symptoms.

Roosa‡ states the prominent symptoms of inspissated cerumen in the ears to be sudden impairment of hearing, tinnitus aurium, vertigo and pain in the ear. Subsequently he says, on the authority of Prof. Mayer, that mental hallucinations have in rare instances been relieved by the removal of inspissated cerumen, and then makes the following interesting statement: "I once saw a lady who, though not regarded as a person of unsound mind, seemed to be such, and who complained greatly of tinnitus aurium in all its varieties. I found the ears full of impacted cerumen; but she utterly refused to allow me to remove it, and I never saw her but once. It would have been very interesting to show the effect of the relief of the tinnitus upon the mental hallucinations of which she seemed to be a victim."

With this very brief reference to aural authorities, I pass to the consideration of several cases in which notable cerebral symptoms were the immediate result of impacted cerumen.

Case I.—Miss C., age twenty-seven, consulted me Sept. 11th, 1866. I found her suffering from vertigo, pain in the posterior region of the head, insomnia, profound melancholy, and hallucinations of hearing. These latter were of a marked character, and were scarcely ever absent during the time she was awake. They consisted of voices which whispered to her words of an exceedingly terrible import, such as "You have lost your soul. You have committed the unpardonable sin. You are too vile to live. Go and kill yourself," etc., etc. Sometimes the sentences were much longer, and occasionally long speeches were apparently made to her. More frequently, however, there was for hours the repetition of some one assertion of her total depravity, or an order to destroy herself.

Though at first recognizing the hallucinatory character of these words, the idea of their reality was gradually forced upon her, and they therefore became true delusions. She began, accordingly, to conceive it to be her duty to act in accordance with the advice she believed herself to be constantly receiving, and hence she made a determined effort at suicide by plunging a pair of scissors into her neck. Fortunately no serious organ was injured, and vigilant watching prevented a repetition of the attempt.

Previous to her coming under my notice she had been subjected to vigorous medical treatment, consisting in the main of cupping and leeching, blistering, purging, and the administration of bromide of potassium in large doses. None of these measures were of any avail. Under the idea that there was uterine trouble, and that the cerebral symptoms were of reflex character, she was sent to an eminent gynæcologist, who, however, declared her generative system to be in good condition.

My attention was at once attracted to the ears by the statement made by her mother, that at first there had been some difficulty in hearing, though after a little while this had disappeared. I therefore began my examination by an inspection of the ears, and at once found that both meati were obstructed by large plugs of inspissated cerumen. These I softened by the introduction of a few drops of a solution of bicarbonate of soda in glycerine, and the next day by injections removed from the ears masses of cerumen as large each as a marble. The patient was then kept quiet for the remainder of the day, and at bedtime the sixth of a grain of morphine was administered hypodermically so as to insure a good night's rest. On awakening the next morning she announced an entire freedom from dizziness, and that the

* The Aural Surgery of the Present Day. New Sydenham Society Publication, 1863.

† The Diseases of the Ear, their Nature, Diagnosis and Treatment. American edition, 1860, p. 80.

‡ A Practical Treatise on the Diseases of the Ear, etc. New York, 1873, p. 147.

voices whispering to her were at a greater distance than they had been. The delusions, as to their reality, still, however, continued. During the day the pain in the head disappeared, as did also the voices. Little by little the force of the false beliefs was lessened, and after a few days there were no further abnormal, mental, or physical symptoms.

Case II.—I. K., a young man twenty-two years of age, came under my observation January 20, 1870, suffering from severe vertigo, noises in the ears, deafness, and intense mental depression. These symptoms had come on suddenly six days before, shortly after a cold bath in which the water had entered the ears. His expression was one of great anxiety; there was an apprehension of impending evil, and he walked the floor of my consulting room with a staggering gait, his hands pressed to his head and tears running down his face.

On examining his ears, which I was induced to do mainly from the facts that there were pain, tinnitus, and vocal resonance, in addition to the special cerebral symptoms, I discovered that both auditory canals were obstructed with cerumen. A few syringes of warm water removed this, and the symptoms almost immediately disappeared.

Mr. X., a lawyer, of Brooklyn, consulted me about three years since for hallucinations of hearing, together with vertigo, pain in the head, confusion of ideas, insomnia, and frequent flushings in the face, from which he had suffered for several weeks. On his way to my house he heard voices apparently saying to him, "What is the use of your going to a physician? You are no use in the world. Go and jump into the river. Jump off the ferryboat; jump, jump now; at this very instant," and so on. He stated that it was impossible for him to follow his profession, for that the voices interfered to the extent of preventing his clearly distinguishing what was being said in his presence. Even as he was talking to me the hallucinations of hearing were present in full force.

These voices did not actually impose upon his intellect, but he stated that he was conscious of a gradually increasing inability to resist accepting them as realities.

Although there were many of the symptoms of cerebral hyperæmia present, I was induced, from the fact that the disorder had come on immediately after bathing in the ocean, during which water had entered the ears, to examine these organs in the very beginning of my interview. Both ears were found full of inspissated cerumen. This was thoroughly softened by the solution of soda in glycerine, and removed by syringing with warm water. On the instant the voices ceased, and the patient left, feeling, as he said, entire relief from his annoying symptoms.

I heard no more of this patient till about two months afterwards, I read in the newspapers of the day that he had been violently abusive in court of the judge on the bench, and had been punished by fine and imprisonment for contempt, and soon afterward his wife called to tell me of the trouble into which her husband had gotten. As she explained it to me, he imagined that the judge was calling him names and cursing him, and had replied in like manner. I had no doubt that there was an accumulation of cerumen, and that the hallucinations of hearing had returned in so aggravated a form as to convince the intellect of their reality. A letter from me to the judge secured his release, and on his visiting me I found my suspicions confirmed. The impacted cerumen was removed, and so far as I know there has been no recurrence of the disorder.

These are only a part of the instances in which impacted cerumen has caused cerebral symptoms that have fallen under my notice, but they are typical, and nothing would be gained by detailing the others.

As regards the cause of noises in the ears I have no information to offer, except to state that it is not the mere stoppage of the internal meatus by impacted cerumen, for such closure does not give rise to any subjective sensation. It is true that if the canal be stopped by the finger a sound is heard, but this is derived entirely from the body, and is probably from the action of the heart, the circulation of the blood through the tissues, muscular contraction, etc. A cork or other substance put into the ear so as to close the canal, and left there without being held by the hand, does not give rise to any sound. If, however, the fingers hold it in place, it transmits the sound from them, as would any other solid substance.—*Hospital Gazette.*

CURE OF SYMBLEPHARON.

By A. W. Calhoun, M.D., Atlanta, Ga., Professor of Eye and Throat Diseases in the Atlanta Medical College.

Miss E——, of Georgia, now in her 24th year, in attempting, when three years old, to remove a vial of nitro-muriatic acid from a mantel, emptied the entire contents upon her face, a quantity of it running into the right eye. The acid destroyed the epithelial covering of the whole conjunctiva of the lower lid and of the adjacent parts of the ball, besides burning the delicate corneal tissue almost to a crisp. Most violent inflammation immediately followed, lasting several weeks and finally resulting in total loss of vision, with partial atrophy of the ball and firm and complete adhesion between the ball and the lower lid in its entire extent, constituting that form of disease known as symblepharon. In addition to this, the edges of the upper and lower lids became adherent at the outer canthus to the extent of about two lines.

As may be imagined, all this presented a most conspicuous and unsightly appearance; the lusterless and shrunken ball, hindered in its movements by the adherent lid, affording the picture of a very marked deformity.

When it became known to her that the separation of the adherent parts, one from the other, would enable her to wear an artificial eye and thus conceal the defective ball, she readily consented to an operation.

Every experienced surgeon will understand and appreciate the necessity of inserting some sort of tissue as a covering for one of the opposing raw surfaces, after dividing and separating parts unnaturally united by burns, etc., in order to prevent their reunion. Upon this fact it is needless to dwell.

For the purpose I had in view, a portion of the rabbit's conjunctiva seemed most suitable, and was used as described below:

The patient was chloroformed and the lower lid separated from the ball, from the inner to the outer canthus, the incisions extending to the bottom of the lid, or as far down as the point at which the lower conjunctival fold should naturally be found. At the same time the outer canthus was slit up, so as to make the palpebral fissure of the same length. This left the whole inner side of the lid and the opposing portion of the ball in the condition of two large contiguous wounded surfaces. After the bleeding had altogether ceased, the rabbit's conjunctiva was prepared for transplantation. A large young white rabbit was selected, and the conjunctiva was rapidly but carefully dissected from its upper lid and the upper portion of the sclerotic, and from the two surfaces of the semilunar fold, at the inner canthus. This gave me a piece somewhat larger than a nickel, though of course of a different shape, which was spread out upon my thumb nail and kept constantly moist with warm water, the epithelial surface being downward or next to the finger. Four sutures were passed through the corners or angles of the conjunctiva, which (with the raw surface inward) was immediately transferred to the wound upon the ball, so that the epithelial surface of the transplanted piece opposed the wounded surface of the lid. The piece was large enough to almost entirely cover the wound upon the ball, and also the bottom of the incision, and to extend slightly up the inner side of the lid. It was made firm in its position by stitching it to the ball in three or four places, and the fold in the bottom of the wound was fastened by passing two sutures entirely through the lid from within outward, and tying them on the surface of the skin. Particular care was taken not to put too much tension upon the piece of conjunctiva, and to keep it smooth in its new position. After thorough cleansing a roller bandage was placed over both eyes and the patient left till the following day. Each day the eye was dressed externally, but for fear of breaking up whatever adhesion that might have already formed, no examination was made of the transplanted piece until after the sixth day. The secretions were merely removed from the edges of the lids and the bandage replaced at once, keeping the patient quiet in bed. When on the sixth day the wound was examined, the rabbit's conjunctiva had taken firm hold upon the ball and that part of the lid covered by it, except upon its very edges, which sloughed off and became smooth in a few days. The transplantation could for some time be distinguished from the surrounding parts by its white appearance, but ultimately became of the same color. The lid was thoroughly separated from the ball, which now moved with perfect freedom in every direction. The lids, at present, admit the comfortable wearing of an artificial eye, which so perfectly conceals all the deformities as almost to appear natural.

It is very essential to the success of this operation that no clots of blood, however small, should remain between the transplanted piece of conjunctiva and the tissue upon which it is placed, and that the surfaces should fit smoothly upon each other and be held firmly together until union has taken place. It is unnecessary to chloroform the rabbit, as it can be kept quiet without difficulty, and moreover, the operation of dissecting the conjunctiva is not at all a painful one. I saw the rabbit several weeks after operating, and strange to say, the ball and lid had cicatrized without the slightest adhesion between them, as I had naturally supposed there would be. This is no doubt due to the fact that the secretions from the wounded surfaces separated them from each other until each had healed.—*Southern Practitioner.*

FEEDING BY THE NOSE.

By T. Newington, Assistant Medical Officer at Bethlehem Hospital.

Having had great opportunities of observing patients who obstinately refuse to take food, and thereby necessitate their being fed by some mode or other, I have come to the conclusion that feeding by the nose is much preferable to any other method. Now, in order to do this in the cleanest and quickest way, with the least struggling on the part of the patient and medical attendant, I have, with the aid of Messrs. Walters & Co., of Palace-road, Lambeth, had an instrument constructed. It consists of a hollow ball, made of vulcanite, which unscrews in the center; to this are at-

tached three tubes, two of which are nearly parallel and fifteen inches long, for inserting through each nostril, while the third is of larger size, and has attached to it a funnel for pouring milk or beef-tea into.

The advantages I claim for the instrument are the following: (1) It does away with the necessity of having to open the mouth, which, with patients with good teeth and strong jaws, is sometimes exceedingly difficult; thus the mouth and teeth are never damaged, which very often happens when the former has to be forcibly opened. (2) It is very expeditious, having two tubes; thus taking less time than when only one is used. (3) The fluid will pass through in three minutes, and none need be spilt; and I think there is less tendency to vomit than when a tube is passed through the mouth.

With regard to the instrument itself, there is nothing to get out of order. No metal is used in its construction; and, as it unscrews in the center, it is very easily cleaned. I will only add that in feeding patients they are laid on their back on a mattress and fixed with a sheet across the body, steadying their head with a towel over the forehead and kneeling on the ends of the towel.—*Lancet.*

OBESITY—HOW CAUSED—HOW CURED.

Corpulence or obesity is, there can be no doubt, one of the most widely spread of the minor troubles to which the human race is subject, and as such worthy of the most careful attention on the part of hygienists and therapeutists. Until within a very few years it was universally taught that the great sources of fat within the human body were the fatty and hydro-carbonaceous elements of the food; and, although it was admitted that the albuminates might, under certain circumstances, give rise to fat, this was put forward rather as a doubtful hypothesis than an admitted fact. The recent labors of physiologists have cast no little doubt upon the old views, and the last writer on the subject of corpulence (Immermann, who contributes an article to Ziemssen's "Encyclopædia") throws over the old views entirely, and adheres absolutely to the doctrines put forward by modern physiologists. It is now held that fat is formed principally from the albuminous elements of the food, just as the fat in fatty degeneration of the tissues is derived from the organized albumen of those tissues. The albuminates eaten with the food are used in part for the nutrition of the albuminous tissues, and the surplus which is not so used undergoes continued processes of metamorphosis and oxidation, and appear among the excretions in the form of urea, uric acid, carbonic acid, and water. If, however, the albumen taken in with the food be in excess of the requirements, or if obstacles stand in the way of its proper oxidation within the body, then a great part is deposited in the form of fat, instead of being burnt up into carbonic acid and water. It is hardly necessary for us to repeat, in this place, the various arguments, physiological and chemical, which have been put forward in support of this view. It must be sufficient to state that they appear tolerably conclusive, and place the albumen source of fat upon a basis which seems to us to be fairly secure.

The value of the other varieties of food in determining obesity depends, it would seem, mainly on their doing away with the necessity of the ultimate oxidation of the non-nitrogenous products of the metamorphosis of the albuminates, and so enabling them to take the form of fat and settle in the tissues, instead of making their escape by the lungs in a more volatile state of being. The formation of fat from albuminates would appear to be greatly favored by this incomplete combustion, and when fats and hydrocarbons are taken with the food as well as albuminates, the former, as regards a dividend of oxygen, are in the position of preference shareholders, and until their claims for oxygen are satisfied, the non-nitrogenous products of the decomposition of the albuminates get a scanty supply, and must be content to remain in a condition of penultimate metamorphosis.

From this it will be manifest that, apart from diet, a deficiency in the supply of oxygen favors obesity. This is evident, whether the deficiency be due to sedentary occupation or to a want of red blood-corpuscles to carry the oxygen to the tissues. On the other hand, a good supply of oxygen, which is favored by rich blood and healthy exercise in the open air, favors the complete combustion of the food and diminishes the tendency to obesity.

It is generally admitted that animal fats are capable of forming fat within the body, but, according to recent views, it is extremely doubtful whether hydrocarbons are capable of a similar transformation. We cannot in this place give the various physiological arguments which seem to support this revolutionary view, but must be content with stating that it is commonly accepted that the hydrocarbons of the diet lead indirectly, and not directly, to obesity.

Although these statements, which come to us with such high authority, change completely the chemical view of corpulence, yet, as a practical disease requiring to be combated by therapeutic measures, it stands precisely where it did. Whether the albuminates or the hydrocarbons be the immediate source of the fat, it is evident that by cutting off the latter from the diet we stand the best chance of attaining a diminution of the superabundant adipose tissue. By permitting the patient to consume a fair proportion of albuminates, we keep his tissues well nourished, prevent anæmia, and encourage that activity of function which is the greatest enemy of undue corpulence; while by cutting off the hydrocarbons we necessitate a thorough combustion of the albuminates, which thus form water and carbonic acid in the place of adipose matter.

The observations of Brillat Savarin on obesity, made more than fifty years ago, are marked by all his well-known acuteness, and his hints to the obese leave nothing to be desired. He insists on three things—(1) Discretion in eating; (2) moderation in sleeping; and (3) exercise on foot or on horseback; but at the same time he remarks that his knowledge of human nature tells him that the self-indulgent mortals to whom he preaches will turn a deaf ear to all his good advice. Brillat Savarin's "antiobesique" diet consisted in excluding farinaceous articles, such as Italian pastes, rice, potatoes, maccaroni, and white bread. In addition, he was most particular not to allow eggs, as if his observant eye had foreseen what physiological chemistry has just told us. He replaced the greater number of farinaceous articles by toast and rye bread, of which latter he astutely observes, people are certain not to eat too much. To allow a sufficient interval between meals, and always to rise from a meal with appetite, were among the precepts which he thought it right to give. These were the precepts of Savarin in 1825; they were the precepts of Banting in 1869, and are the precepts of Immermann in 1878.—*London Lancet.*

THE POISON GLANDS OF THE CENTIPEDES.

It has long been known that the Chilopod Myriopoda, commonly known as Centipedes, which are carnivorous in their habits, kill their prey by a poison injected at the first bite of their formidable nippers. The seat of the glands secreting the poisonous fluid was, however, unknown, the organs formerly supposed to secrete the venom being found to pour their secretions into the cavity of the mouth, and not into the nippers. Mr. McLeod, during a residence in Java, took the opportunity of examining some of the large centipedes with which that island abounds, and especially *Scolopendra horrida;* and finding that, as above stated, the glands which might easily be taken for poison glands had nothing to do with the nippers, which, nevertheless, always exhibited a very distinct orifice at the tip, he was led to search for the glands in the interior of those organs themselves.

The process he adopted has of late given admirable results in the investigation of the anatomy of many animals; namely, the preparation of sections of them in various directions after they had been immersed in melted paraffin, the subsequent hardening of which keeps all parts in their natural positions during the operation of cutting. By this means he detected the poison gland, which is situated partly in the actual biting portion of the nipper, and partly in the broad basal joint which supports the latter. The grandular apparatus consists of a chitinous duct leading to the orifice at the apex of the organ, and forming the axis of the gland. It is perforated in its course by a multitude of small apertures, each of which leads into a minute cylindrical tube terminating in a long secreting cell, the whole mass of these cells being arranged in a radiating fashion around the duct. The entire organ is surrounded by a membrane, and has the general form of a four-sided prism. Notwithstanding its comparatively small size, Mr. McLeod has detected the same arrangement in *Lithobius forficatus* (the common European centipede).—*Bull. Acad. Roy. de Belgique.*